POWER PLANT ENGINEERING

Trade-mark reg. U. S. Pat. Office

SEMI-MONTHLY

VOL. XXII. CHICAGO, APRIL 1, 1918 No. 7

Cincinnati's New Source of Electric Energy Supply

UNUSUAL COAL HANDLING SYSTEM AND UNIQUE CONDENSER INSTALLATION FEATURES OF WEST END POWER STATION OF UNION GAS & ELECTRIC CO.

ON ACCOUNT OF continually increasing load demands and the relatively low economies being realized by the use of more or less obsolete equipment in existing generating stations, the Union Gas & Electric Co., of Cincinnati, Ohio, has in course of construction along the north bank of the Ohio River and within one mile of the city's main business section a new central power station which, due to local conditions and requirements, embodies many unusual and interesting features. This plant, to be known as the West End Station, will when placed in operation have a capacity rating of 50,000 kv.a. although it is planned, and provisions have been made to increase this ultimately to 100,000 kv.a. When completed, it will be the only central station serving Cincinnati and surrounding territory with electric energy, as the present generating station which has a capacity rating of approximately 30,000 kv.a. will, as soon as the new plant is capable of carrying all of the load, be remodeled and converted into a substation for local distribution service.

Located as it is, the West End plant will at all times be assured an abundant and continuous supply of water for condensing and boiler feed purposes and on account of its close proximity to the Ohio River and the trunk lines of several of the railroads entering Cincinnati, coal may be brought in by water or rail. This may be

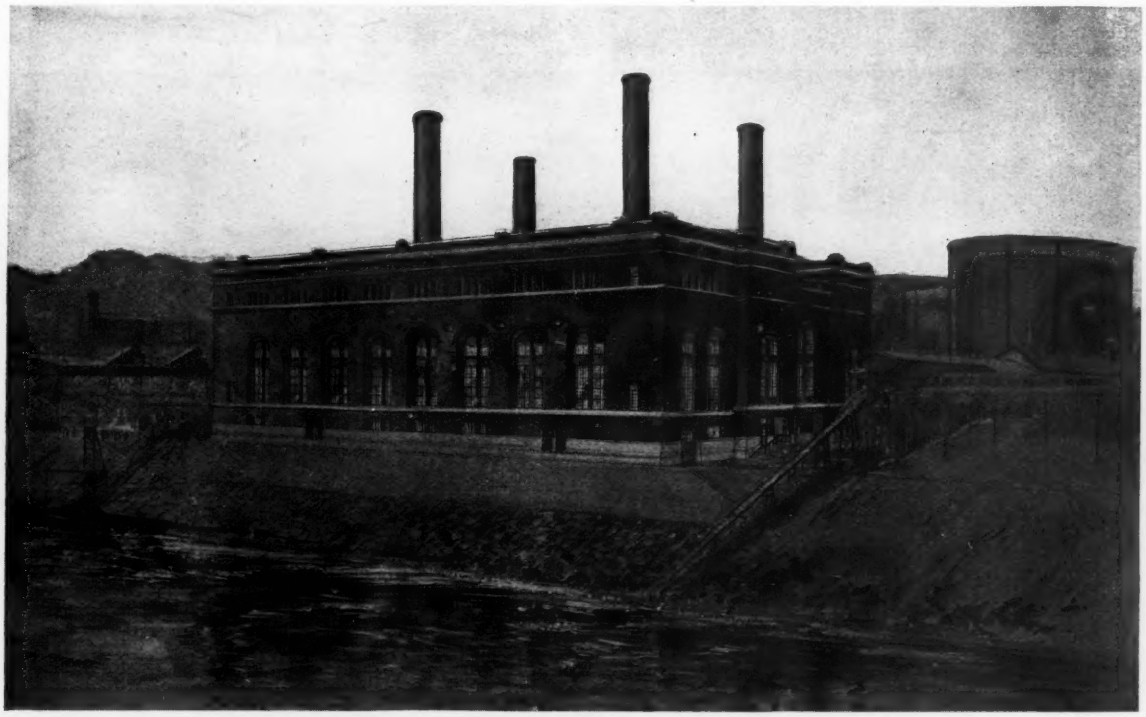


FIG. 1. GENERAL VIEW OF WEST END STATION AS WHEN COMPLETE

delivered either to an indoor coal storage pit in the boiler room or it may be placed in the out-of-door underground storage yard which has a capacity of about 50,000 tons. For the handling of this, there has been provided an electric gantry crane with 175-ft. span and grab bucket.

Directly opposite the power house is a terminal substation of high-pressure natural gas mains connecting with West Virginia fields, and in order to insure continuity of service in spite of any coal shortage which may at any time arise, it is planned to equip the boilers with gas burners so that in the event of an emergency or at such times at which there may be a surplus of natural gas, as occurs during the summer months, this may be used instead of coal. The use of this fuel will, without doubt, tend materially to reduce operating costs.

As shown in Fig. 1, the building housing the steam and electric generating and control equipment is of steel, concrete and brick construction with overall dimensions of about 330 by 220 ft., and a uniform height of 100 ft.; a party wall parallel to the length of the structure divides it into turbine and boiler rooms, the former with a width of 68 ft. and the latter with a width of 150 ft. Exterior walls are of pressed red brick tied in with a backing of concrete which forms the interior walls.

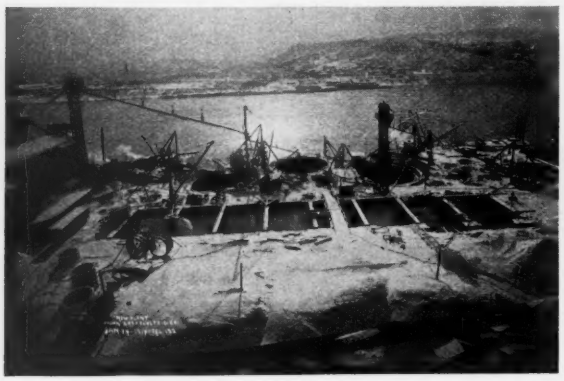


FIG. 2. SHOWING CONDENSER AND INTAKE WELLS AND INDOOR COAL STORAGE UNDER CONSTRUCTION

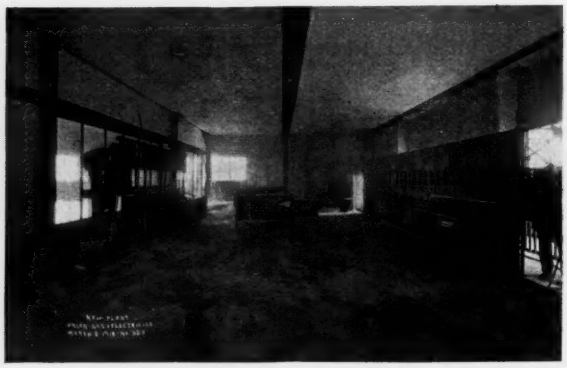


FIG. 3. INTERIOR OF CONTROL ROOM DURING CONSTRUCTION

A somewhat radical departure from present day power station design and an arrangement whereby considerable ground space has been saved and costly foun-

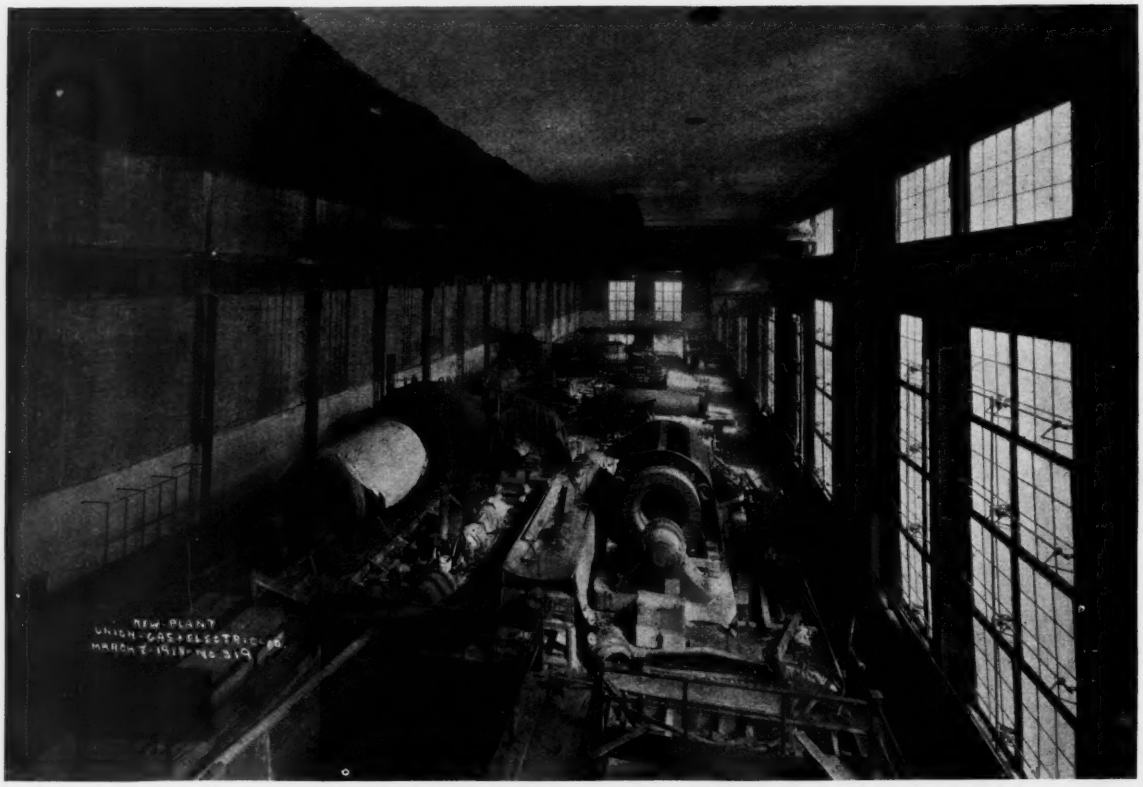


FIG. 4. GENERAL VIEW OF TURBINE ROOM

dations eliminated, is the location of the switch house above the turbine room. This form of construction has in addition resulted in a structure of uniform height and has made it possible at any time in the future to allow extensions to the turbine room in any direction desired, except, of course, toward the boiler room side.

In the Boiler Room

As may be noted by referring to Fig. 7, there are at present being installed two batteries of four boilers each, each battery occupying one side of the boiler room with a firing aisle between. One battery and one turbine

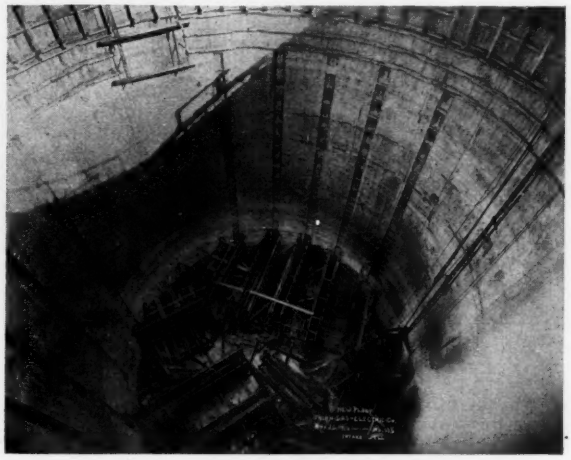


FIG. 5. INTERIOR VIEW OF CONDENSER WELL

will comprise a unit, although the boilers are each of such capacity that with full load on the turbine but three of them will be able to support readily all of the steam required, thus allowing one boiler to be shut down for cleaning and repairs.

Each of the boilers is of Babcock & Wilcox make and of the cross drum type, and in addition to being equipped with a 16-retort Westinghouse underfeed stoker, will be provided with an individual Babcock & Wilcox superheater and a Sturtevant economizer having 8256 sq. ft. of heating surface. The boilers have 12,625 sq. ft. of heating surface each and will ordinarily be operated at a pressure of 250 lb. gage; the temperature of the steam will, however, by means of the superheaters, be increased 250 deg. F. above that corresponding to this pressure.

The stokers will be driven by individual variable speed direct-current motors and the forced draft employed for use in connection with the furnaces will be furnished by motor-driven Buffalo blowers. Each battery of boilers is to be served by a 15 by 175 ft. brick-lined steel stack.

Handling of coal and ashes within the plant will be accomplished by the most simple, direct and economical means capable of being devised for an installation of this size and type. The indoor coal storage bin which has a capacity of approximately 7500 tons, extends the entire length of the boiler house and receives coal from bottom-dump cars placed over the bin on either one of two sets of standard gage tracks supported by I-beams parallel to the rails. One of these tracks is on either side of the bin, just inside of its outer edge, and in order to facilitate removal of the coal from the center of the bin the sides of this have been made sloping. A grab bucket operated by an electric crane placed near the roof of the boiler house and spanning a large protected opening in the floor of the firing aisle, will be used to transfer the coal to the individual boiler hoppers, each of which is of such size as will accommodate a 24-hr. supply of fuel.

After being discharged by the stokers, the ashes will be deposited in receiving hoppers below the boilers from where they may be removed as required and deposited in cars on tracks provided for that purpose. One set of these tracks, which are parallel to and on the same level as the coal car tracks, is installed under each row of boilers. Switching of coal and ash cars within the station yards will be done by the company's own electric locomotives.

Water for feed purposes will be taken from wells connecting with the river and will be fed to the boilers by Worthington three-stage, double-suction, centrifugal pumps. Two of these pumps will be steam-turbine driven, while the third will be operated by a direct-connected electric motor.

Turbine Room Equipment

Some of the more interesting and unusual features of design and construction of this installation are to be found in the turbine room. At the present time the electric generating equipment consists of two 25,000-kv.a., 13,200-v., three-phase, 60-cycle, turbine-driven, alternating-current units of General Electric make, and arranged as indicated in Fig. 4. Each of these sets is equipped with its individual direct-connected, 210-kw., 250-v. exciter, and although either of these units is of sufficient capacity to supply all of the current which

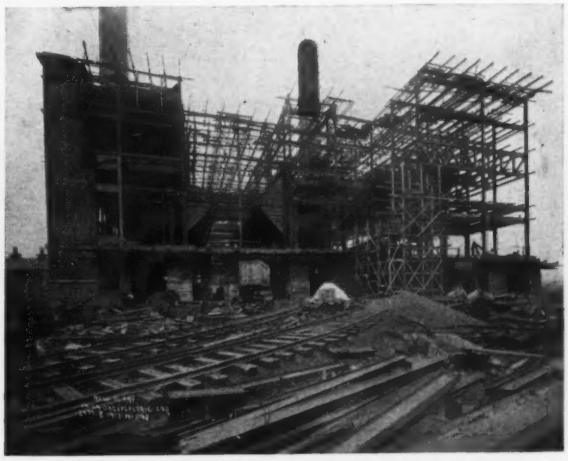


FIG. 6. STATION UNDER CONSTRUCTION SHOWING ARRANGEMENT OF BOILERS AND ENTRANCES FOR COAL AND ASH CARS

might at any time be required for the excitation of both main generating sets, there will, for emergency service, be installed a double generator turbine set, one end of which will deliver direct current at a voltage suitable for excitation purposes, while the other end will supply current at 600 v. for the station auxiliaries which ordinarily are to receive current from one of two, or both, 750-kw. rotary converters. Each of the double generator units will have a normal rating of 200 kw.

As a special precaution against possible shut-down due to loss of excitation, there will be installed a 126-cell storage battery, rated at 160 amp. and 250 v. on an 8-hr. discharge.

Condensers and Wells

On account of the seasonal variations in level of the waters of the Ohio River, which have reached a maximum of 70 ft., and in order to insure an abundant supply of water for boiler feed and condensing purposes in times of drought, and still eliminate, as far as possible excessive pump lifts, the engineers engaged on this project were required to solve a most difficult and unusual problem. Below the turbine room and serving both as generating set and to some extent as building foundations are five reinforced concrete wells. The two largest of these, the condenser wells, have an internal diameter of 68 ft., a depth from the basement floor of 84 ft., and have walls 8 ft. thick which also serve as foundations for the main generating units, two of these being placed as shown in Fig. 8 over each well. Between these wells is the intake or screen basin having a diameter of 60 ft., a depth of 86 ft., and receiving its supply of water through a 163-ft. intake tunnel 10 ft. wide and 10 ft. high, also of reinforced concrete but with walls 2 ft. 6 in. thick. The river end of the intake tunnel, which is supported on piles to prevent possible damage due to washing away of that part of the river bed in close proximity thereto is open; but, to avoid entrance of leaves, sticks and other debris which otherwise might find its way into the condensers and pump suctions, the intake well is equipped with two sets of screens. The first of each of these consists of a stationary grill work of iron bars behind which is a group of four motor-driven Link-Belt traveling screens followed by a set of stationary screens.

The condensers, with auxiliaries, of which there are two sets on the floor of each well, receive their circulating water through 54-in. concrete ducts connecting the pump suctions with the intake well, and as the entire system from the entrance of these ducts to the discharge wells is sealed and therefore acts as a syphon, the work of the circulating pumps will be limited to that of overcoming the internal resistance of the members comprising the system.

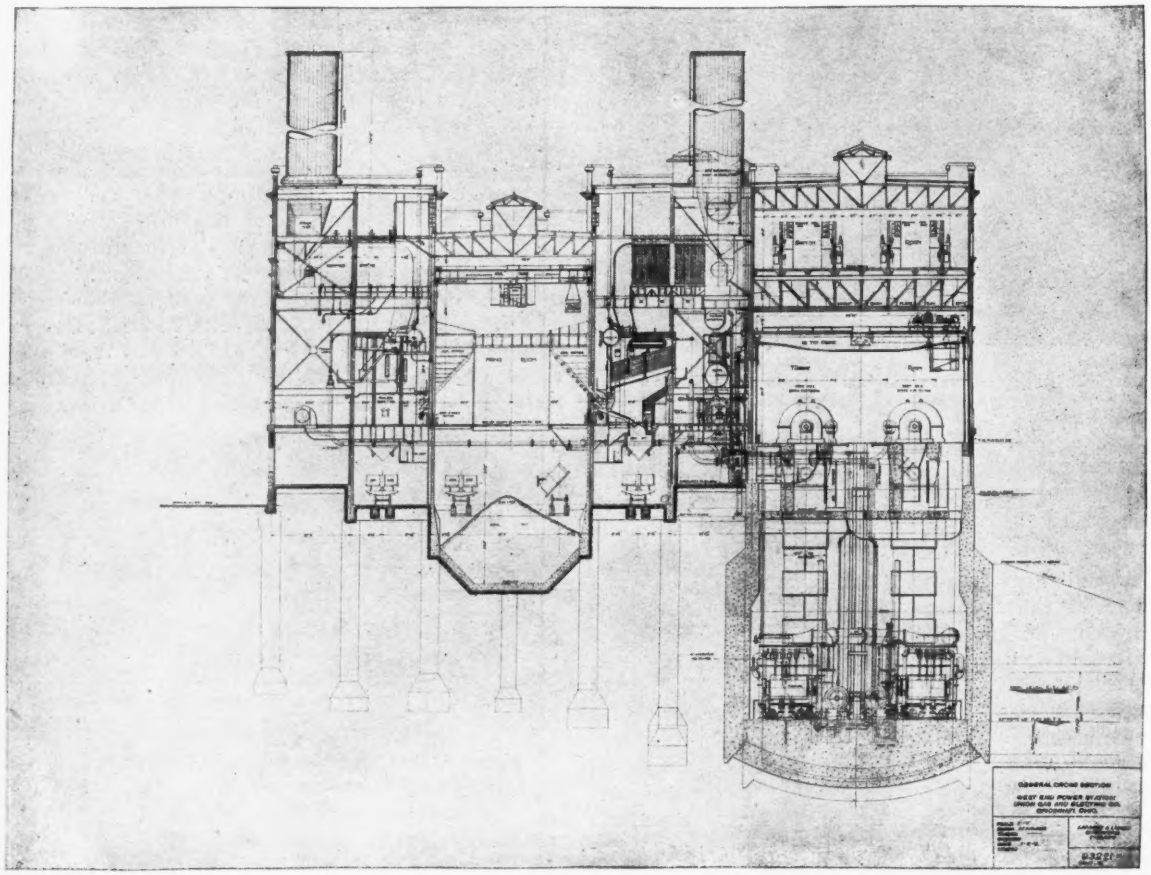


FIG. 7. SECTION THROUGH STATION SHOWING CONDENSER WELLS

Relative location of discharge wells is as shown in Fig. 8. These, each of which has an internal diameter of 17 ft. and 3-ft. reinforced concrete walls, discharge through 6 by 10-ft. tunnels which merge into a single 10 by 10-ft. tunnel with walls 2 ft. 6 in. in thickness and with a length of 214 ft.

Flow of water through the condensing system is controllable by means of sluice gates placed in the ducts connecting the intake and condenser wells.

After being discharged by the turbines, the exhaust steam passes through a vertical line 13 ft. in diameter and 62 ft. long and enters the condensers. Each of these

units which, together with all auxiliaries, are of Worthington make, have a condensing surface of 52,000 sq. ft., and are capable of handling 330,000 lb. of steam an hour. The pumps employed in conjunction with the condensing units are each driven by individual direct-connected, three-phase induction motors, and like the condenser proper are placed on the floor of the condenser well.

Access to this equipment is by means of ladders carried along the side walls of the wells; provision has, however, been made for the installation of small elevators for this purpose.

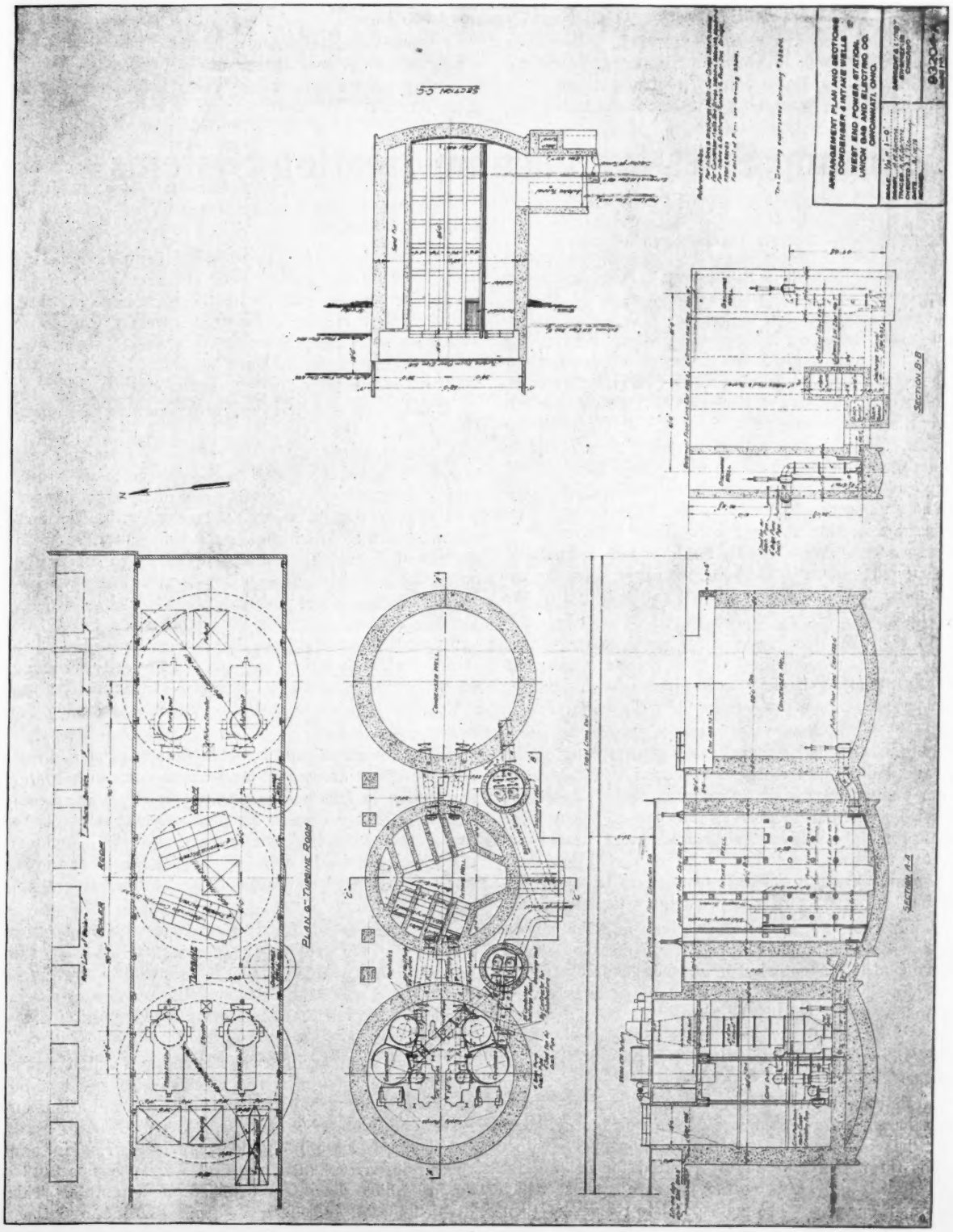


FIG. 8. PLAN OF TURBINE ROOM AND DETAILS OF WELLS

Control and Switching Apparatus

As previously stated, the switch house, as also the control room, have been placed above the turbine room, the latter in such a way as will at all times give the operators a full and unobstructed view of the turbine room. According to plans, the principal control room equipment will consist of three main switchboards, for the control of the generators, exciters and feeders, and a number of auxiliary panels which will carry such equipment as curve drawing instruments, automatic voltage regulators, synchronizers, relays, etc., etc.

All high-voltage switching is to be done in individual cells, bus bars and oil switches being isolated in brick and stone compartments. Main generator bus sectionalizing and feeder switches which have been specified for this installation are to be of the triple pole, single throw, solenoid operated, oil circuit breaker type, the former with a rated capacity of 2000 amp., while the feeder switches will be of such design as to enable them to carry 600 amp.

All generator and feeder circuits will be fitted with reactance coils of such capacity as will reduce to a minimum any system disturbance which may occur due to short circuits.

Pump Sizes for Vacuum Heating Systems

Development of Rule Based on Radiating Surface. By M. William Ehrlich

AMONG the methods of modified steam heating, the vacuum system is extensively favored for large buildings. Generally it is not essential that a vacuum be maintained in the piping. The main requirement is that there be a difference in pressure between the steam in the supply pipes and the water of condensation in the return piping. To obtain this pressure difference, some form of pumping device must be used. For steam drive, the direct-acting pump is especially suited to the purpose. For electric motor drive a power head, or triplex pump or sometimes a rotary pump is used. In every case, however, the steam is supplied to the radiators at a pressure of 2 to 5 lb., while the pump draws or exerts a suction on the return line. This creates a difference in pressure usually running into 2 to 10 in. of vacuum, the magnitude of which depends on the extent and manner of piping as well as the height of the building.

As there are many specialties made to go with a vacuum heating system, and of these there are many different types and varieties, a general term for designating such arrangements is best expressed by the name "return line system."

In the combined steam-electric power plant of the average building, preference is usually given to the steam pump for vacuum heating service. It is a type especially adapted to this class of work because the exhaust may be utilized in the feed water heater and because the pump speed is easily regulated, which is a desirable feature for taking care of the variable heating load that actually does change with the weather.

Because of the nature of this load and the work a vacuum heating pump is called on to do, the size as recommended by manufacturers is often a mystery to the engineer. The duty imposed and the large size of the pump cannot readily be reconciled except by those expertly versed in the subject. Here is the explanation. It applies to electrically driven as well as direct-acting steam pumps.

In determining on the capacity of the vacuum pump for a heating system, the size of the working cylinders must be considered in the computations. The other end is the measure of power required for driving the unit and is governed by the pressure against which the pump operates. The main point to remember, then, is that the amount of condensation the pump has to handle during the greater part of the day is only a fraction of that compared with the work imposed when the steam is first turned into the system at the start. This, in a good many cases, means at least once a day, and the pump must therefore be of ample capacity to take care of this large amount of condensation.

If the pump were not capable of handling this quantity of hot return water, the circulation would be sluggish and it might therefore require too many hours to get the building warmed to the desired temperature.

For proper service therefore, the pump must be proportioned to remove quickly the large amount of condensation resulting from the steam being turned on in the morning, together with the quantity of air in the system of radiators and piping, in order that circulation will be rapid and positive under all load conditions. For this reason, vacuum heating pumps as installed, are usually rated at about 1/10 their normal capacity, which means that such pumps are capable of easily handling 10 times the nominal condensation from the heating system under average operating conditions during the day.

The theoretical capacity of a pump is not a direct measure of the amount of condensation or return water it can handle. In a direct-acting pump, there is considerable leakage around the plungers and through the pump valves. This loss, known as "slip" reduces the pump capacity by about 25 per cent; in other words, small pumps are good for only ¾ of their theoretical capacity.

This theoretical capacity may be determined by multiplying the area of the working cylinder by the length of the stroke and then by the number of strokes. For a pump with two cylinders, the number of single strokes are equal to the operating speed multiplied by two.

Take a single cylinder direct-acting vacuum pump of 4-in. bore by 5-in. stroke running at a speed of 50 strokes a minute. What amount of direct radiation can it serve adequately?

The area of a 4-in. cylinder equals 12.57 sq. in. and times 5-in. stroke, then times 50 strokes, equals 3142.5 cu. in. which the pump displaces in a minute. This divided by 231 cu. in., gives about 13.6 gal. and times

8⅓ lb. equals 113.3 lb. per min. as the theoretical capacity of the pump. As only 75 per cent of this is useful working capacity, then the pump is capable of handling 85 lb. per min. and times 60 min. gives 5100 lb. of condensation an hour as the net maximum capacity. Rated at 1/10 of this capacity, the pump will then adequately handle a normal condensation of 510 lb. an hour.

As this normal condensation or hot return water from a vacuum heating system using direct steam radiators is 0.25 lb. per square foot per hour, then 510 divided by 0.25 gives 2040 sq. ft. direct radiation. This, therefore is the installed heating surface a pump with 4-in. bore and 5-in. stroke operating at 50 strokes a minute, will care for successfully. Increasing the running speed of the pump would result in greater capacity.

Practically the speed of a pump is limited by the piston travel. For a pump with a 5-in. stroke operating at 50 strokes a minute as in the foregoing case, the piston travel would be 5 in. divided by 12 and times 50, which gives approximately 21 ft. per minute.

For vacuum heating pumps, a maximum allowance of 80 ft. per min. piston speed is usually made when designing the mechanical features of a short stroke pump. For pumps of a length of stroke 18 in. or over, the maximum piston speed as designed is for a travel of 100 ft. per min. Under actual operating conditions of continuous service, such pumps should be operated at not more than 60 per cent of the designed speed.

Taking all these factors into consideration, and the service that may be expected during the operating period of the heating season, these features may be combined to eliminate some of the figuring. On such basis the following purely arithmetical formula has been developed. It is a simple computation in plain multiplication and division. Knowing the working dimensions of the pump, the installed sq. ft. of direct radiation that heats the building on a vacuum system and that the pump will adequately serve, will then be equal to:

$$\frac{d \times d \times l \times n}{2} = \text{sq. ft. radiation}$$

In this computation d is the cylinder diameter in inches; 1 is the length of stroke in inches and n is the number of single strokes a minute.

To see how this formula is used, consider the same 4 by 5-in. vacuum pump operating at 50 strokes, as in the previous example. This should give a check on the figures and also demonstrate how simple it is to use the formula. Accordingly, the installed radiation this will care for under the given conditions is equal to:

$$\frac{4 \times 4 \times 5 \times 50}{2} = 2000 \text{ sq. ft.}$$

which agrees closely with the complicated figuring that was gone through in the first part of the article; and this solves the mystery of the vacuum heating pump.

System in the Power Plant

By J. C. Hawkins

IT IS probable that no two plants were ever operated exactly the same, and the men employed therein change shifts at widely different hours in different plants as best suits the conditions, not all having the same hours off, and sometimes, due to not having a well planned system of changing watches, some of them have more time off, or at more favorable times than others. In some plants it is considered necessary for the men to work overtime when one of them gets a day off or is sick, in which case they actually make up the time they are off. It is the lot of the majority of power plant men to work seven days a week, although there is no good reason why they should not have a day off at regular intervals as well as any other employe. This is a question that is usually decided by the chief engineer, who if he so desires, can make such arrangements in the hours that some of the men can be off duty a day at regular periods, and he may be sure that any effort in this line on his part will be well repaid by better satisfied employes and better efficiency among the men. But the method of procedure whereby each and every one gets the same amount of time off each month, and no other plan is fair, is not always easily worked out, and some well thought out system is necessary in this respect.

The plant running 24 hr. a day is the only one that presents this problem. In many instances the men do not changes watches but stay on the same watch week after week. If all of them get the same wages they should all have the same privileges and the same amount of daylight work which as a rule is the most desirable, and this is especially true in summer. There are plants, however, where it is the policy of the men to "hit the hay" for a few hours every night in relays, trusting to kind providence to keep the feed pump running and the oil flowing during this time, although they will, in nine cases out of ten deny it, and there is nothing that encourages this practice more than the knowledge that it is seven nights a week, year around, with no change. The practice of paying the night man (where they do not change watches) lower wages than the day men doing the same work is entirely wrong in principle for the reason that even though the day man may have more repair work to do, it required as much skill and the same grade of license to operate the plant at night as in day, and the extra disadvantage of working nights and trying to sleep days more than offsets the extra work done on the day shift. If there is any discrimination in the wages, it should be in favor of the night men.

I have in mind a plant, the Government Printing Office, of Washington, D. C., where the night men receive 20 per cent more wages per week than the day men, not only in the power plant, but throughout the entire institution. Some of these men change watches, but the night shift gets higher wages than the day shift because night work is less desirable than day work, and should have additional compensation.

Many times the upkeep of the machinery is dependent upon one of the engineers, usually the day man who does not receive any more wages, but in addition to operating the plant has to care for the machinery and do con-

siderable extra work. This in my opinion is wrong and unfair. It tends to make the other men careless, and does not give them a chance to exercise their skill and ability as engineers, simply makes them operators and a part of the machinery.

My idea of the proper way to handle this situation is to divide the care, maintenance and responsibilities between the two or three engineers, assuming there is only one on each watch, giving each one a certain part to look after. If this practice is followed out, the responsibility for any mis-adjustments such as keying a bearing up too tight or packing a pump improperly, can easily be placed, and any except emergency repairs, which are sometimes necessary to keep the plant running, are made only by the engineer who has charge of the repairs of that particular piece of apparatus. Then there is another good reason for this division of the responsibility, and that is that not infrequently one of the engineers may be better trained to take care of the engines or turbines while another may be better on pumps, boilers or electrical equipment, depending to a great extent on how he received his training as an engineer, whether he came up from the boiler room, machine shop, engine room or from the electrical department.

PROPOSED SCHEDULE OF CHANGING WATCHES

MONTH		WATCH									
FEB.		FIRST		SECOND				THIRD			
DAY	DATE	ENGR	FRMN	COAL PASSER	ENGR'S HELPERS	FIREMEN	COAL PASSER	ENGRS	FRMN	COAL PASSER	MEN OFF DUTY
FRI	2	1	4	7	2,10,13,12	5,14,15	8,17,6	3,11	6	9	
SAT	3	1	4	7	2,10,13	5	8	3	14	9	12,6,9,11,15,16
SUN	4	1	4	7	13	5	16	11	6	9	2,13,5,8,3,10,14,17
MON	5	1	4	7	2,10,13,12	5,14,15	8,16,17	3,11	6	9	
TUES	6	1	4	7	2,10,13,12	5,14,13	8,16,17	3,11	6	9	
WED	7	1	4	7	2,10,13,12	5,14,13	8,16,17	3,11	6	9	
THUR	8	1	4	7	2,10,13,12	5,14,15	8,16,17	3,11	6	9	
FRI	9	1	4	7	2,10,13,12	5,14,13	8,16,17	3,11	6	9	
SAT	10	1	4	7	2,10,12	5	8	3	12	16	13,6,9,11,14,17
SUN	11	1	4	7	13	14	17	11	6	9	2,3,5,8,1,2,10,15,16
MON	12	12	4	17	2,10,13	5,15	8,16	3,11	6	9	1,4,7
TUES	13	12	4	17	2,10,13	5,15	8,16	3,11	6	9	1,4,7
WED	14	1	4	7	2,10,13,12	5,14,13	8,16,17	3,11	6	9	
THUR	15	1	4	7	2,10,13,12	5,14,15	8,16,17	3,11	6	9	
FRI	16	1	4	7	2,10,13,12	5,14,13	8,16,17	3,11	6	9	
SAT	17	1	4	7	2,10,13	5	8	3	14	16	12,6,9,11,15,17
SUN	18	1	4	7	12	15	17	11	6	9	2,3,5,8,13,10,14,16
MON	19	1	4	7	2,10,13,12	5,14,15	8,16,17	3,11	6	9	
TUES	20	1	4	7	2,10,13,12	5,14,15	8,16,17	3,11	6	9	
WED	21	1	4	7	2,10,13,12	5,14,15	8,16,17	3,11	6	9	
THUR	22	1	4	7	13	14	17	11	6	9	2,12,3,8,5,10,15,16
FRI	23	1	4	7	2,10,12	5	8	3	15	16	13,14,9,11,6,17
SAT	24	1	4	7	2,10,12	5	8	11	15	16	3,1,4,9,13,6,17
SUN	25	1	4	7	13	14	17	3	6	9	2,10,5,8,12,11,15,16
MON	26	12	13	16	13,10	14	17	2,11	5	8	1,4,7,9,6
TUES	27	3	6	9	13,12,10	14,15	17,16	2,11	5	8	1,4,7
WED	28	3	6	9		14,15	17,16	2,11	5	8	1,4,7
MAR											
THUR	1	3	6	9	1,10,12,13	4,14,15	7,17,16	2,11	5	8	
FRI	2	3	6	9	1,10,12,13	4,14,15	7,17,16	2,11	5	8	

REGULAR MEN IN PLANT:-
1- EBERSOLE
2- ROBINS
3- CASEY
4- COOLEY
5- WISE
6- GOHR
7- FRAZER
8- DODSON
9- JACKSON
10- BURDIN, 11- MOLLOY- OILERS DO NOT CHANGE WATCHES

EXTRA MEN FOR RELIEF WORK:-
12- FARREL
13- MANSON
14- HOGMAN
15- MC. DOWELL
16- STRONG
17- NOBLE

Extra men to do regular work about the plant and heating system of distant buildings and clean boilers when not on duty in power plant.

Men on first watch to get a day in place of holidays when they change to day work.

All regular power house men to change watches every four weeks. First watch 12:00 to 8:00 a.m. Second watch 8:00 to 4:00 p.m. Third watch 4:00 p.m. to 12:00 p.m.

Men on first watch to get the day in place of holiday at the end of that shift, otherwise men on duty Feb. 28 would work their regular shift.

The practice of dividing the responsibilities has been carried out in some plants, and each of the engineers knows at all times that he is responsible for the upkeep and proper operating condition of the equipment under his care. If, for instance, the packing blows out on one engine, or through some cause the governor does not work properly, the engine is shut down and another started, if available, and the engineer who has charge of the engine in trouble makes the necessary adjustments or repairs when he comes on duty whether it is day or night. If the engine cannot be spared, the repairs must of course be made at once by whoever is on duty, but should be given proper attention by the man who has charge of the engine. After a short time the man in charge of the engine becomes more familiar with its peculiarities, knows just what has been done to it, how much it can safely be keyed up at one time.

A plan of upkeep of this kind makes it essential that the engineers change shifts at regular intervals that they may know the operating conditions of the machinery under their care at all times, and under all conditions of load, and as this requires men of equal ability, although possibly along different lines, they should receive the same wages and have the same hours off duty or on. It is as a rule necessary in the 24-hr.-a-day plant to have some extra laborers and boiler cleaners who do certain work that need not be done at night. This, of course, is looked after by the day engineer or man in charge of the boilers who received his orders from the chief, and who should have supervision of the work.

It is also advisable to have some extra men to relieve the engineers, firemen, oilers or coal passers in case of sickness or during their regular days off. These extra men can be used to a good advantage about the plant when not doing relief duty. If such is the case it is best to have the relief work come during the day shift for the reason that these extra men may not be as familiar with the plant, and in case of trouble can refer to the chief engineer for assistance. When not doing relief duty these extra firemen may clean and repair boilers and other boiler room machinery or do other odd jobs which frequently arise, and the relief engineer may do machine work, assist the day engineer in making repairs or in any extra work, do pipe work, look after the heating system, if there is any, and assist in many other places where extra help is required for a short time.

If extra oilers and coal passers are kept for relief work, some other work can be found for them during the time they are not doing relief duty such as blowing tubes, cleaning combustion chambers, and numerous jobs about the plant. In some plants no relief oiler is used, but the engineer looks after the oiling on the relief watch, or the relief engineer or fireman acts as oiler when the regular man is off duty.

Where there is a relief man for the engine room and also for the fire room, there is no good reason why the regular men should not have a day off every week or two weeks at the outside, and it should be on full pay if they are employed by the week or month. It will give the men a chance to rest up and get a little enjoyment and in the end will be money well spent. An exception to the rule of being off may be advisable in case of the shift after midnight, where the watches shift at regular intervals. In this case the men work every night until the end of the period when they get all the time due them at one time when they change to day work. One night off is of little value to the men on this watch because they have to sleep during the day or go 24 hr. without sleep, and this also keeps the relief man on day work except in case of sickness or other emergencies.

Where any part of the force change watches, the entire force of engineers, firemen, oilers, coal passers, etc., should change at the same time and for the same periods and the boiler room men should have the same time off as the engine room men. After the engineer becomes acquainted with the men on his watch, he can handle the plant to a better advantage because he knows just what to expect of each man, and the men know just how he wants the work done, which will result in a generally higher efficiency of the men.

The boiler room should be considered of as great importance as the engine room, and the men employed therein should be as skilled in their line, for the reason that the boiler room is where the greater amount of money is spent or saved, and a dirty, ill kept boiler room and carelessly operated boilers with the settings full of cracks, a condition which is most apt to be found where low wages are paid, will not attract the highly skilled class of boiler room men that the value of the money equivalent handled warrants. The advantages of boiler room instruments, such as draft gages, CO_2 recorders or Orsats, steam flow meters, etc., which should be employed in every plant, as they will prove a valuable investment, will be of little or no value unless the men who are constantly handling this part of the plant are skilled and understand their use, and it requires something more than common laborers in the boiler room if high efficiency is desired.

It therefore becomes necessary to have a system of handling the men which will result in the highest efficiency and most economical operation. If such a system is in force, the men can plan ahead to just what days they will be off duty and can arrange their private affairs accordingly. This also relieves the chief engineer of the worry of who will be off or on duty because he has the layout before him, and can plan the work accordingly. Without such a system it not infrequently happens that two or more men wish to get off at the same time, where only one can be spared, which may cause confusion or possibly discrimination.

It would be difficult if not impossible to formulate a set of rules that would fit all plants because of the dissimilarity of operating conditions and policy of the company; but this is one of the problems with which the chief engineer has to contend, and the sooner he devises a suitable and impartial system the less trouble will he have with the men and the more harmonious will the work go on and with less worry on his part. These things are for the best interests of the company; although it may cost something to put it into effect, the returns will more than justify the expense.

Coal and Its Selection

By Haylett O'Neill

On page 121 of the issue of Feb. 1, Mr. Polakov makes the timely statement that the B.t.u. value of coal as determined by the calorimeter is not the true criterion of the value of coal for furnaces. Moreover, he states in effect that the only correct method of comparing the heating value of different coals is to burn them in our furnaces with load conditions prevailing and that the heating value of fuel is to be measured by only that part of the B.t.u. value which is represented by the combined boiler and furnace efficiency in actual practice. In other words, what you can get counts more than what there is to get.

The efficiency of a steam engine depends upon a Rankine efficiency or highest possible efficiency defined by the operating conditions of steam pressure, steam temperature and back pressure, and a "utilization efficiency" or efficiency ratio which represents the percentage of perfect efficiency obtained by the engine designer, builder, and operator. That is, if the ideal efficiency is 30 per cent and the absolute thermal efficiency 12 per cent, the efficiency ratio equals 40 per cent, which measures the true criterion of engine excellence. If the ideal efficiency equals 35 per cent, but the thermal efficiency equals 12.5 per cent, the efficiency ratio is only 35.7 per cent, which indicates a poor engine even though less heat units in the steam are expended per kilowatt hour.

The same principle should be applied to the generation of steam. Quality of coal, climatic conditions, etc., entirely outside of the province of boiler furnace design and operation are determining factors of boiler efficiency. That is, the absolute boiler efficiency as ordinarily stated is the percentage of the calorimeter value of fuel converted into heat in steam, whereas the true criterion of boiler efficiency should be the ratio of the heat converted to that available from the coal after deducting necessary losses. Such necessary losses may be enumerated as follows:

1. Due to heating theoretical amount of air required for combustion from outside air temperature to boiler water temperature. (See Fig. 1; 11.92 lb. air required for average soft coal.)

2. Due to heating combustible from outside air temperature to boiler water temperature.

3. Due to evaporating and superheating moisture in coal from outside air temperature to boiler water temperature.

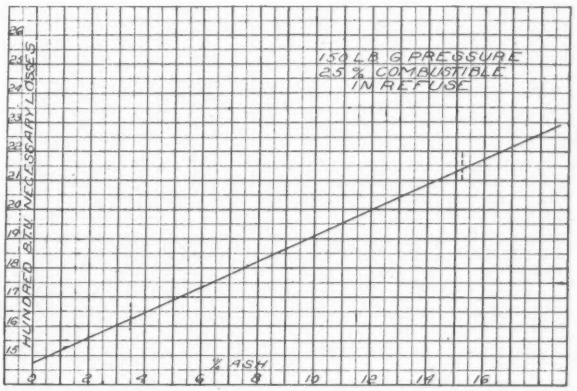


FIG. 2. NECESSARY LOSSES OF FUEL WITH VARYING PERCENTAGE OF ASH

4. Due to evaporating and superheating moisture formed by burning hydrogen in coal from outside air temperature to boiler water temperature.

5. Due to heating moisture in the theoretical amount of air required for combustion, from outside air temperature to boiler water temperature.

6. Due to sensible heat in pure ash dumped to ash pit.

In addition these are losses practically necessary:

7. Due to sensible heat in combustible dumped to ash pit when refuse contains a practical minimum per cent of combustible.

8. Due to unconsumed combustible in ash with a practical minimum per cent of combustible.

To illustrate, assume the following conditions:

1. Boiler pressure	= 165 lb. Abs.	= P_s
2. Boiler water temperature	= 366 deg. F.	= T
3. Outside air	= 70 deg. F.	= T_A^s
4. Relative humidity	= 70%	= M

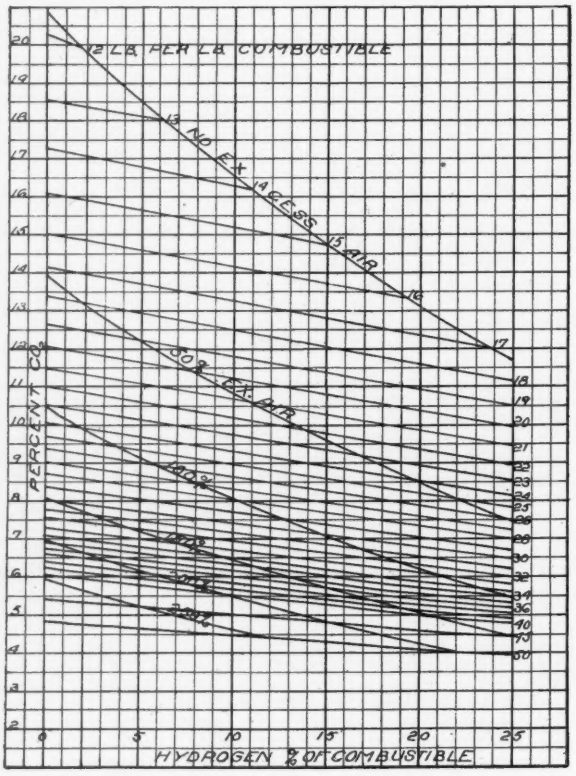


FIG. 1. CHART SHOWING EFFECT OF EXCESS AIR ON PER CENT CO_2 IN FLUE GAS WITH VARYING AMOUNTS OF HYDROGEN IN FUEL

5. Moisture in Coal	= 2%	= Q
6. Hydrogen in coal	= 5%	= H
7. Practical minimum of combustible in ash	= 25%	= C
8. Temperature of ash dumped	= 1800 deg. F.	= TA_s
9. Ash in coal	= 6%	= A
10. B.t.u. per lb. coal (colorimeter)	= 14,500	= B.t.u.
11. Special heat of refuse (avg.)	= 0.2	= S_R
12. Special heat of water vapor (avg.)	= 0.46	= S_s

13. Assume dry coal = Ash + Hydrogen + Carbon

14. Specific heat of air = 0.2375 = S_A

The formulas for losses per pound of coal are:

1. Loss $= S_A \times 11.92 \times (T_s - T_A)$

2. Loss $= \frac{Q}{100} \times (1223 + 32 - T_A)$

3. Loss $= \left\{\frac{(100 - A)}{100}\right\} \times S_R + (T - T_A)$

4. Loss $= 9 \times \frac{H}{100} \times (1223 + 32 - T_A)$

5. Loss $= 0.0018 \times 11.92 \times S_s \times (T_s - T_A)$

6-7. Loss $= \frac{A}{100 - C} \times S_R\ (TA_s - T_A)$

8. Loss $= \frac{C \times A}{100\ (100 - C)} \times 14{,}610$

For the conditions stated, total necessary losses per pound of coal = 1749 B.t.u. The ideal efficiency equals

$$\frac{14{,}500 - 1749}{14{,}500} = 88 \text{ per cent}$$

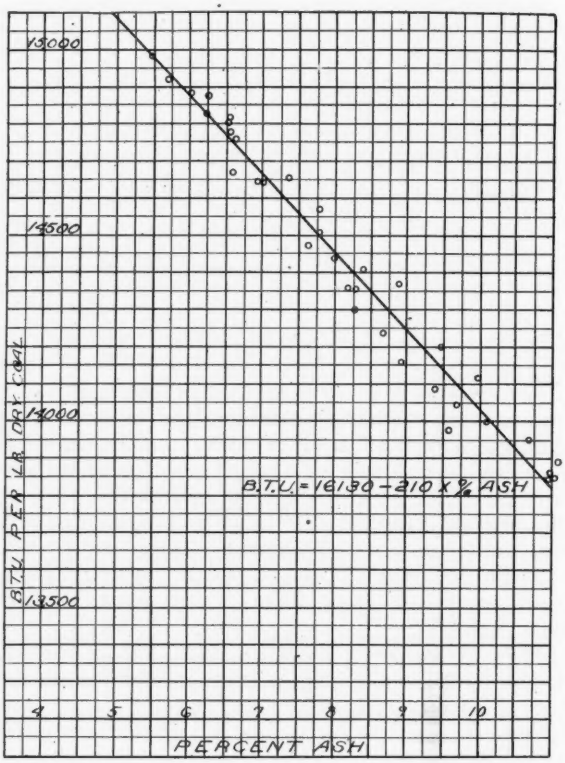


FIG. 3. B. T. U. PER POUND OF DRY COAL (W. VIRGINIA)

It can be shown that for average good West Virginia coal,

$$\text{Ideal efficiency} = \frac{1.208 \text{ B.t.u.} - 4832}{\text{B.t.u.}}$$

Chart 2 shows the necessary losses summed as a function of percentage of ash in coal. Chart 3 shows an average relationship between percentage of ash and B.t.u. for average West Virginia coal. From curves 2 and 3, the relationship between ideal efficiency and

ash in coal is calculated for Chart 4. It is evident that the ideal efficiency for coal from this particular section will vary from 86 to 88 per cent. If the absolute boiler efficiency equals 70 per cent, the utilization efficiency or "figure of merit," equals

$$\frac{70}{86} \text{ or } \frac{70}{88} = 81.4 \text{ or } 79.6 \text{ per cent}$$

The exact calculation demands an exact coal analysis, but the above serves to illustrate that our present system of evaluating coal on straight B.t.u. value as determined in the calorimeter and evaluating boiler operation on absolute efficiency is inadequate.

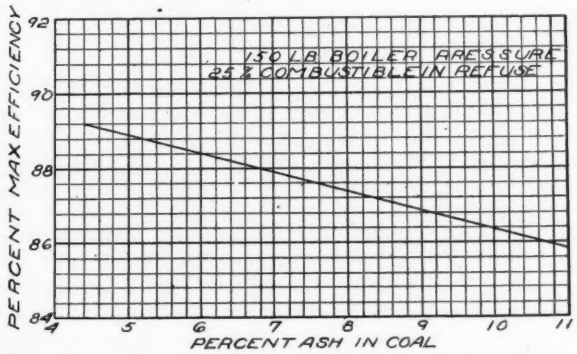


FIG. 4. MAXIMUM AVAILABILITY OF HEAT—W. VIRGINIA COAL

Certain coals clinker more than others; but there will always be doubts as to how much of the trouble is inherent in the coal and how much is due to inadequate design and imperfect operation of the furnace.

Coal should be valued according to the available heat measured by the ideal efficiency, and utilization should be valued by the proportion of the ideal obtained in practice.

A Power Plant Regiment

THE 37th Engineers Regiment is being formed for early over-seas service. Its work will consist of the erection and operation of power plants and transmission lines for serving American troops.

The Regiment is in need of skilled engine men, steam, gas, etc.; of electricians; and of other trades, such as machinists, blacksmiths, sheet metal workers, oxy-acetylene welders, brick layers, boiler makers, pipe fitters, stock keepers, pattern makers, etc.

If you feel you are qualified as to experience, if you desire to join the regiment, send to Major A. B. Kratz, Chief of Engineers Office, War Dept., Washington, D. C., a statement of your education and experience, accompanied, if practicable, by letters of recommendation. If deemed qualified, you will,

If in Draft Age, be sent authorization for your induction into service, by your Local Board, for service with this regiment.

If past Draft Age, be sent an order authorizing any recruiting officer to enlist you for the regiment and forward you to the Post at Fort Myer, Va.

If already enlisted, be notified that the Commanding Officer of this regiment will approve your application for a transfer when same comes before him. This application must originate with you and be addressed, and sent first to your Company Commander.

Opportunities will be good for qualified men to attain a non-commissioned officer's rank.

The pay of a private is $30 a month and of the highest non-commissioned officer about $96 a month. Clothing, subsistence, medical attention, etc., are furnished in addition to pay.

A married enlisted man must allot to his wife at least $15 of his pay each month. In addition thereto the Government will add $15 for a wife without a child, and $25 for a wife with one child, $32 for a wife with two children, and $5 more for each additional child. Further details of allowances to other dependents will be furnished.

Insurance: Life and Liability, is also provided by the Government at low rates.

For information concerning commission in Engineer Reserve Corps, address the "Chief of Engineers, War Dept., Washington, D. C."

For further information: address, The Adjutant, 37th Engineers, Ft. Myer, Va.

Water Power in Congress

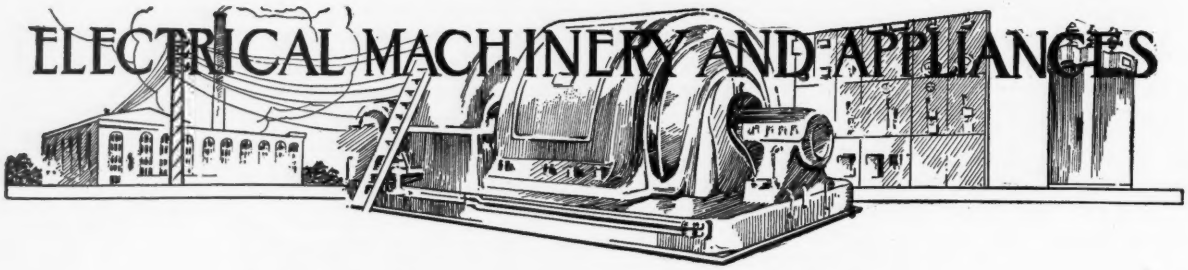
FOR 12 yr. progress in water power development has been delayed by lack of adequate legislation to permit it under conditions that would interest the investment necessary. Controversy between those who represented private interest and those who insisted on over severe regulation in the interest of national control has blocked any advance toward a solution of the difficulty.

At the last session of Congress the Shields Bill was passed by the Senate as a compromise measure but failed to reach action in the House. War emergency has now driven home the vital necessity of utilizing our wasted resources and the Administration has prepared a bill, by co-operation of the Secretaries of Agriculture, War and the Interior, which aims to promote speedy development of water powers, on terms attractive to capital, yet protecting the rights of the public. This bill is under consideration by a special committee of the House and is of greatest importance, not only as a war measure for alleviating the fuel stringency, but as a means of conservation for industrial development after the war. Approval by Gifford Pinchot, a pronounced conservationist, and by Secretary Lane, who has the confidence of business men, indicate that the bill is satisfactory from both viewpoints.

It is essential for quick action that both houses of Congress be convinced that the country favors the bill. Especially should the Senate be won away from any prejudice in favor of trying to resuscitate the Shields Bill at the present time. The self interest of power plant men argues for exerting all possible influence on Congressmen and Senators to secure the passage of the bill, both to aid the development of power usage and to relieve the coal situation.

EVERYTHING IN life must come to you through other men, and your success will, therefore, be in the proportion that you can influence others.

ELECTRICAL MACHINERY AND APPLIANCES



Powerful Electric Locomotives

NEW PASSENGER EQUIPMENT OF CHICAGO MILWAUKEE & ST. PAUL RAILWAY INCREASES HAULING CAPACITY WITH SUBSTANTIAL POWER SAVINGS

CONCENTRATION of enormous horsepower in a single locomotive unit has long been the recognized tendency in railway practice. This originated from considerations of crew economy and the greater efficiency of large units. The limits of the two-man crew have been reached, while further increases in size will yield but small improvements in efficiency. Recourse must be had to some new form of motive power if necessary increases in hauling capacity are to be made.

It is fortunate in many ways that electricity has thoroughly proven itself for this purpose. On the Chicago Milwaukee & St. Paul Railway, its use over the 440 miles of line over the Rocky Mountains has been so satisfactory in operating efficiency, hauling heavier trains, and keeping traffic moving in all weathers that the railroad's decision has recently been made to electrify another mountain division—the 170 miles from Othello, Wash., over the Cascade Range to Seattle and Tacoma. With the completion of this work, a distance equal to that from New York to Cleveland will be under electrical operation. To handle passenger traffic over this and the Rocky Mountain division, the St. Paul has ordered 10 Baldwin-Westinghouse electric locomotives.

The new locomotives will have a length of 90 ft. over couplings and will weigh 266 tons when ready for service. Each machine will have a single cab, extending over practically its entire length. The running gear consists of two units of the familiar "Pacific" type, placed back to back. Each will have a four-wheel guiding truck, three driving axles with 68-in. driving wheels, and a two-wheel trailing truck, connected by a heavy link and the cab will be free from pulling strains.

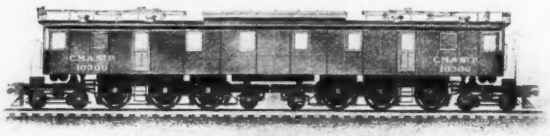
Each locomotive will carry twelve motors, arranged in pairs permanently connected in series, each pair being geared to the same driving axle through a quill, whose spring mounting gives a certain amount of flexibility for cushioning the road and pulling shocks. By this means the only weight not spring-supported is that of the wheels, axles and journal-boxes.

These will be the most powerful locomotives in passenger service. Each can haul a 950-ton train of twelve coaches over the St. Paul's entire mountain section at the same schedule speed made by two or three steam engines. Each locomotive can deliver 3200 hp. indefinitely, and 4000 hp. for one hour. At starting a pull of 112,000 lb. can be exerted on a train while the normal maximum speed on level track is 60 miles per hr., and up a 2 per cent grade is 25 miles per hr.

One great advantage of the electric locomotive is that it will maintain its efficiency over a wide range of speeds. For these locomotives there are nine economical running speeds, varying from 8 to 56 miles per hr. These are secured by various series and parallel groupings of the motors, and by placing shunts around the fields.

Of cardinal importance in these locomotives are the arrangements for regenerative braking. Due to long grades, wear on brake-shoes was excessive, and the possibility of accident from brake-failure was always present. Where the locomotive motors become generators, there is no difficulty in bringing a train down the longest grade at a higher speed than before, since less margin of safety for equipment failures is required. In addition, a substantial saving in power is made.

In connection with the regenerative features, each locomotive has generators geared to the axles of the pony



TYPICAL CHICAGO MILWAUKEE & ST. PAUL RAILWAY ELECTRIC LOCOMOTIVE

trucks. These supply current to excite the main-motor fields during regeneration; at other times while running they supply current for the air compressors. When this supply is not available the compressors take power from a small motor-generator set, or from the control storage battery. Thus a constant supply of compressed air is available at all times whether the trolley is energized or not.

Due to the extremely cold weather common in the Rockies, train heating is of vital importance. To assure its independence of trolley line conditions, each locomotive will carry an oil-fired steam boiler with storage tanks for 750 gal. of oil and 7500 gal. of water.

Running gears and mechanical details for these locomotives will be furnished by the Baldwin Locomotive Works and electrical equipment by the Westinghouse Electric and Manufacturing Co.

Inductance of Conductors in Conduit

By R. H. Earle

IF a single conductor carrying an alternating current is placed by itself in a metallic tube, the alternating current will induce in the tube eddy currents. These eddy currents may, under certain conditions, heat the tube to a dangerously high temperature. Furthermore, the heat developed represents a loss of electrical energy. Also, if the conductor carried within the metallic tube is of considerable length, the voltage drop over the length will be considerably greater than it would be with the same conductor carrying the same current and not enclosed in the tube.

Where all the wires of an alternating-current circuit, that is, two wires for a single-phase circuit and three wires for a three-phase circuit, are installed in the same metallic tube, the tendency of one of the wires in the tube to produce these inductive effects is neutralized by the tendency of the other conductor or conductors in the circuit to introduce these effects. Hence, where all of the wires of an alternating-current circuit are carried close together or in the same tube, their aggregate inductive effect is practically nil.

The inductive effects described above are due wholly to certain properties of alternating currents. They therefore are not associated with direct-current circuits, hence with direct-current circuits precautions toward their elimination are not necessary.

Saving Electricity by a Steam Boiler

Using Surplus Energy of Hydro-Electric Installations to Heat Water

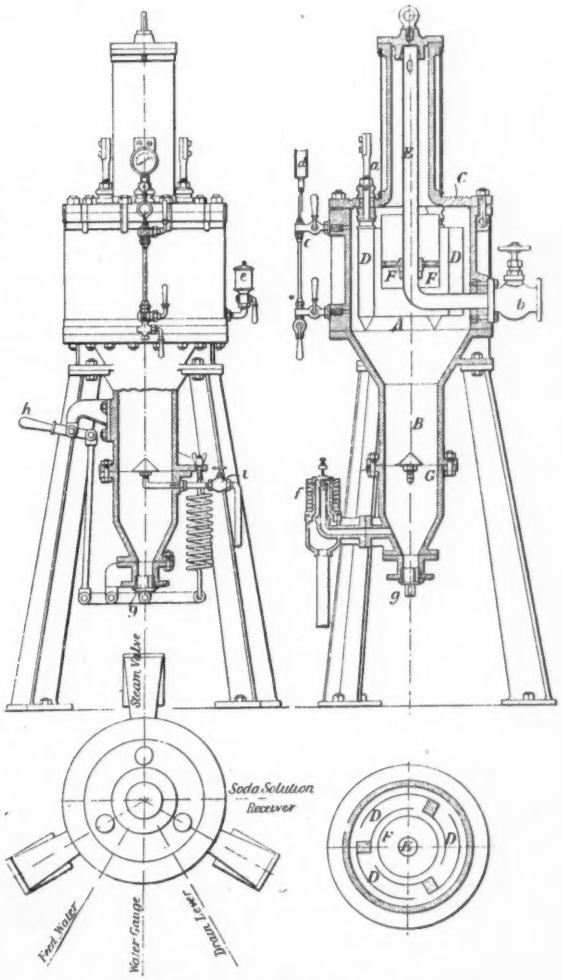
THE idea seems at first thought crazy enough, but it is being done, commercially. In hydro-electric plants, much energy goes to waste during periods of light load and heavy flow. The storage battery is too expensive to use as a means of storage, but electric current is used to heat water in boilers under high pressure, and this can immediately be used for steam making, or stored in boilers for future use.

Illustrations herewith, from Engineering, show the device used in Italy, and known as the Revel apparatus.

Any voltage may be used from 200 to 3600 volts and the boilers are constructed for pressures up to 225 lb. In the sectional view, A is the steam making space, B the cold water space, C the cover which acts as a steam dome and carries three brass rods, *a*, insulated from the cover. Steel electrodes, D, are rigidly fastened to these rods. Current passing between these electrodes through the water in A, heats the water in overcoming its resistance. Steam rises into the dome around the baffle, F, and is conducted away by pipe E and valve *b*. Water enters by the nozzle, G, and valve *i*, the level being automatically controlled by regulator *f*. Valve *g* acts as a drainage and safety, opening when the pressure gets too high, to permit water to escape, or by handle *h*, for drainage. Steam gage and water glass are provided as shown. This design is for 500 volts, but the high-tension type is the same except as to shape of electrodes and size of steam dome, which is equal in diameter to the space, A.

To start the action the switch is closed, valve *i* is opened, and a small amount of soda solution introduced from receiver *e*, Fig. 1, to lower the resistance of the water.

When the water level reaches the lower edge of the electrodes, current begins to pass to heat the water and to make steam. Production increases as the level rises, until the working pressure required is reached. Then the regulator comes into action and the level is held constant, and as the steam production is in proportion



DETAILS OF REVEL ELECTRIC STEAM BOILER

to the immersion of the electrodes, that remains constant also.

To stop the apparatus, valve *i* is closed, then valve *b*, and the valve *g* is opened by handle *h* until the ammeter returns to zero, showing that no current is flowing. The switch is then opened.

When the water leaves a sediment or scale, this is blown out every 5 or 6 hr. by increasing the water feed and opening valve *g*, which can be done by careful manipulation without changing the water level or the rate of making steam.

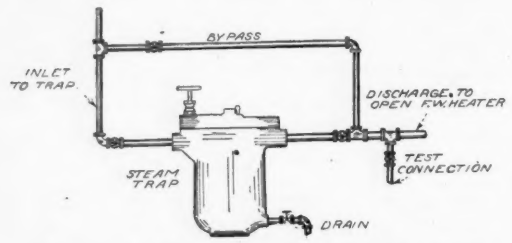
Increasing Power Plant Economy

MANY SAVINGS CAPABLE OF BEING REALIZED BY PROPER MAINTENANCE OF APPARATUS. BY C. T. BAKER

WE frequently find, when inspecting power plants, that one of the really big "leaks" can often be traced to the innocent looking steam trap located in some out of the way place and supposed to drain automatically some part of the steam piping system, or steam separator, located at the throttle of the engines or turbines.

Too often no provision has been made to test these traps for leakage such as results from cut-seats, or discs, broken parts, or other things of a similar character common to trap operation.

The accompanying illustration shows the proper method of piping arrangement for connecting up steam traps and affords a quick means of making a test for leakage. The discharge from the trap is carried to an open feed-water heater, or to some other point where the condensate may be claimed for re-use. A test valve is provided on the discharge pipe near the trap by simply putting a tee in the line as shown. To test the trap open this valve and if the trap is "blowing through" due to any of the causes mentioned above, steam will leave the valve in a continuous flow. Of course, if the various trap returns are simply led to an open tank and are not



A DESIRABLE SCHEME OF TRAP CONNECTIONS

connected to a common discharge header, it may be possible to detect leakage without the test valve; this is, however, rarely the case. The bypass arrangement shown is to provide a means of handling the condensation ordinarily handled by the trap and is to be used only when the trap is undergoing repairs or adjustment.

It is true that it costs a little more to connect up traps in the manner shown, but the saving effected in operation resulting from such a method more than justifies the additional first cost of installation.

The writer found a condition not long ago in a plant having six traps operating under 150 lb. steam pressure and discharging into a common return. When tested, three of them were found to be passing steam at full boiler pressure, which was later found to be due to badly cut seats of the discharge or outlet valves. In each case the size of the discharge and inlet connection of the traps was 1¼ in. It is therefore evident that the fuel waste resulting from these leaks was enormous.

STEAM PUMPS

IT IS SURPRISING how much energy is wasted as a result of low efficiency in the average steam driven pump of either the duplex or single cylinder type. These pumps are used extensively in a variety of manufacturing and power plants and ordinarily as long as they continue to deliver somewhere near the water requirements, they are kept going regardless of the speed at which they must be operated to deliver this water, and as a rule are not looked into until the water delivered by them begins to fall short. Repacking a pump and renewing the valves is not in many cases sufficient to insure economical operation.

A brewery in a middle western city had about twenty pumps installed, all direct steam driven and ranging in capacity from 50 to 500 gal. of water per minute. A new chief operating engineer found the valve seats in the water end of these pumps in such condition that it was impossible to secure water tight valves regardless of the make of valve used.

A pump valve reseating machine enabled the valve seats in all pumps to be faced up without disturbing in any way the setting of the pump, and when the valves were put back in place, the pumps operated like new and the steam saving was considerable.

As a check on the operation of these pumps, a revolution counter was purchased which with a few slight modifications rendered it adaptable to any of the pumps. The plan then was to get an accurate reading of the speed of some pump at a time it was known to be in first class condition. At the same time, readings of the steam gage and the water pressure gage on the pump discharge line were taken, both gages having been previously calibrated.

At regular intervals each pump was tested under the same pressure conditions and the speed taken by means of the revolution counter, and if the speed was found to be in excess of the speed recorded per unit of time when the pump was first tested, it was evident something was wrong and an investigation made to locate the trouble. This practice lead to the saving of fuel and insured a sufficient supply of water more regularly than under the old method.

An attachment was provided for the valve re-seating machine which made it possible to use this same machine for re-seating globe valves in use on pipe lines, and this item alone resulted in the saving of much steam and water, due to leaky valves, which, of course, meant a still further saving in fuel.

EXCESS AIR LOSSES

A MEDIUM SIZE electric lighting plant in a southern city secured a good price on fuel oil and accordingly changed the furnaces under the two 200-hp. water-tube boilers to permit the burning of this oil instead of coal. Excellent results were obtained and a substantial fuel saving was affected. During the light load period, it was found possible to cut out one of the oil burners, as one burner would carry the load without difficulty. However, flue gas analysis taken during a light load period showed excessive excess air losses. Closing the ash pit doors on the side of the furnace where one burner was cut out did not overcome the trouble, as the doors being

open on the side of the working burner could admit air greatly in excess of what was required for one burner since the entire grate area was in communication with the air supply through one set of ash pit doors. The trouble was entirely overcome by simply running an 8-in. brick wall from the floor of the ash pit to the bottom of the grate, parallel to the boiler setting, and the entire length of the furnace, thus dividing the ash pit into two separate compartments and making it possible to control the air supply to each burner independently. This increased the furnace efficiency materially during the light load period.

Tight Valves

The writer has personal knowledge of a method employed by the engineering department of a concern operating a number of small and medium sized electric lighting properties, having amongst them various kinds and types of prime movers some 10 or 12 automatic balanced slide-valve engines, some single cylinder, and some compound condensing. Investigation showed that none of these engines were free from valve leakage and most of them showed an unusually bad condition in this respect. Some of the engines had cut valves and seats and badly scored and cut pressure plates, but in most instances the valve leakage was due to shoulders having worn on the valve seats caused by load variations and consequent change in valve travel. Most of these engines operated about 80 per cent of the time on loads considerably less than half and often as low as one-quarter, and this, of course, meant a comparatively short valve travel, which in time would wear a shoulder on the valve face. Then, as the peak load would come on and the valve travel would lengthen out, it is evident that as the valve passed over this shoulder, a considerable area of the valve would not be in contect with its seat, thus giving the steam an excellent chance to blow through.

A surface plate of dimensions sufficient to permit its use on valves of the largest engines was purchased and the following method was employed to make the valve steam tight. The valve was removed from the steam chest and placed on the surface plate, which had previously been given a light coating of red lead and oil, then by rubbing the valve on the surface plate the high spots of the valve, if there were any, would be shown up, the valve would then be scraped at these high points until a good and full contact was indicated over the entire valve surface between valve face and surface plate. The valve was then used to indicate the high spots on the valve seat and the seat scraped until a good contact between the seat and valve was obtained, in the same manner as the valve was faced up by the surface plate. This being done, the valve was ground in on its seat with coarse grinding compound until a good gray surface was indicated, and the finishing touch then taken with a fine grinding compound.

The pressure or balance plate and ring on the back of the valve, if any were used, were also faced up on the surface plate and ground in on the seat.

During the scraping and grinding operation, the valve and cylinder is kept as hot as possible and after the engines are put back in service, they are usually run a few days and the valves removed and examined, which would indicate whether any further grinding was necessary. After this examination, the steam engine indicator was applied and the valves were properly adjusted.

The importance of keeping after the matter of engine valve leakage does not seem to be realized by the average engineer, but it is the source of one of the greatest steam losses in any plant using engines of that type. It is not to be inferred, however, that this type of engine is wasteful, for such is not the case, as they will give excellent economy when properly taken care of.

The automatic-governed piston valve is just as liable to wear shoulders on its cage when running under the conditions described above, and should, as a consequence, receive frequent inspection and testing. Usually, however, where badly worn valves and cages are found, the remedy lies in fitting new valves and cages to the engines, as this type of valve does not lend itself so readily to re-grinding as do other types. This type of modern engine, however, is also capable of excellent steam economy when properly cared for.

For Cleaner Coal

BEGINNING Mar. 11, an order went into effect from the Fuel Administration that a system of inspection would be put in force for impurities in coal, and such as was condemned for carrying too large a percentage of dirt and slate would be sold at 50 cents a ton less than the government fixed price at the mine.

Coal will be inspected at the mine by government traveling inspectors, the intent being to reinstate cleaning of coal at the working faces and the employment of slate pickers so as to reduce the proportion of ash content to the standard for normal times. The inspector may order mining suspended in any workings where the product is naturally unfit for market until proper cleaning methods are adopted, except where a stoppage will endanger life or may result in flooding or other injury to the mine.

Any coal found loaded in railroad cars which has not been properly prepared may be rejected by the district representative of the Fuel Administration, and unless unloaded and reprepared, the buyer may deduct 50 cents a ton from the authorized price at the mine for that grade of coal. But the buyer may, after examination, accept the coal and pay full price. Further penalty may be inflicted on the mine operator for repeated violations of the order.

Tests by the National Tube Co. on the strength of round top and round bottom threads for pipe joints seem to indicate that the round thread is superior to the Briggs thread in tensile strength of joint, impact, resistance, amount of bending possible at joint, and resistance of joint to vibration. Annealed joints offer better resistance to shock, bending, and vibration than unannealed, and are equally strong against tension. Round thread on the pipe may be used with Briggs thread on the coupling satisfactorily. As between an angle of 55 deg. and 60 deg., there is little to choose, but the 60-deg. thread gave slightly better results on the whole.

Boiler Repairs by Oxy-Acetylene Welding

By Mark Meredith

WITHIN recent years the practice of making good certain defects in steam boilers by means of oxy-acetylene welding has become very general, and repairs of a most varied nature are nowadays carried out in this way.

The varied forms of repair include the welding up of fractures and grooves, reinforcing the calking edges of leaky riveted seams which have become reduced as a result of repeated chipping and calking, thickening up plates which have become reduced in thickness over small areas by corrosion, cutting out defective pieces of plate and welding in new pieces, etc. While there can be no objection to the carrying out of certain repairs by oxy-acetylene welding process, it is a fact that there is a tendency to apply the process in many cases where it is quite unsuitable for the purpose.

It has to be borne in mind that welding by the oxy-acetylene flame is not usually quite so effective as welding by hand in the ordinary way. In the latter case, the parts to be welded together are not only melted into each other, as it were, but they are effectively hammered together so that the different particles of metal become thoroughly intermixed, and the whole becomes a practically solid piece of metal.

In the oxy-acetylene welding process the parts welded together can scarcely be said to have become so thoroughly united that they form a solid piece of metal. In reality, one piece adheres more or less firmly to the other, and the joint, in many cases, is, to a certain extent, more of a soldered than a thoroughly welded joint. Much, of course, depends upon the welder. When the work is badly done it is often possible to remove the metal which has been applied in the form of a solid strip.

It is for this reason that joints made by the oxy-acetylene welding process are not entirely satisfactory for parts subjected to tension, hence, those defective parts of a steam boiler which are in tension should not, as a rule, be repaired by this process.

Where parts are in compression, the pressure tends to close the surfaces together, so that even if the joint is not perfect, there is not the same risk of failure occurring. On the other hand, when the parts are in tension, the pressure is constantly tending to open the joint, and the slightest imperfection is therefore inadmissible.

In Lancashire and Cornish boilers the shell is in tension, while the furnace and flue tubes are in compression. Hence, with such boilers, it is, generally speaking, only defects which occur in the cylindrical tubes which ought to be made good by oxy-acetylene welding. Nevertheless, it is a fact that defects in the shell are frequently "made up" in this way, particularly where secondhand boilers are concerned. Indeed, the oxy-acetylene welding process has proved of great service to dealers in secondhand boilers, inasmuch as it not only enables them to get defects made good, but it furnishes a means for concealing defects, so that an intending purchaser is prevented from finding out that the boiler is in any way defective. For instance, a dealer in secondhand boilers purchases a boiler which has been on damp seatings for a number of years, and which has, in consequence, become more or less severely corroded along the surfaces of contact with the seating blocks.

Owing to the defective state of the shell, he is able to purchase the boiler at a comparatively low figure. If he is unscrupulous, he will then have the corroded portions made up to the original thickness by oxy-acetylene welding, and if the work is neatly carried out, the fact that the boiler has been seriously corroded at the seatings may never be discovered. The dealer may thus obtain a high price for a boiler which is quite unsuited for any really useful pressure. If, of course, the intending purchaser takes the precaution of having the boiler examined by a reliable insurance company before purchasing, he is not likely to be "taken in" in the manner referred to, because an experienced inspector will generally find out the defective parts that have been made up by acetylene welding, whereas an ordinary engineer not trained in the work of boiler inspection, would fail to do so.

In addition to having corroded shell plates thickened up, unscrupulous dealers in secondhand boilers have been known to remove patches and replace these by new plates, carefully welded in by the oxy-acetylene process. It is well known that a boiler with any patches on whatever is unlikely to sell for a good price, hence the reason that an unscrupulous dealer will resort to the practice referred to. The practice is obviously a risky one, particularly where external shell plates are concerned.

As a general rule, the cutting out of defective portions of plate and replacing by welding in new pieces is inadmissible except in places where the plates are well stayed, as for example, in the fire boxes of boilers of the locomotive type, and in the combustion chambers of marine boilers. In such cases the stays belonging to the defective plate, will, of course, have to be removed with the plate and new stays afterward fitted.

The oxy-acetylene flame may be used with advantage for cutting out defective portions of plate, as it effects the work rapidly and satisfactorily. The intense heat of the flame does not appear to leave any injurious effect upon the plate material, beyond rendering the metal just at the edges somewhat hard. By taking off a thin chipping all around, the hardened metal may all be removed.

The repair of fractures by the oxy-acetylene welding process requires considerable care, as otherwise the atomic forces of expansion and contraction will be brought into play with serious effect, giving rise to further fractures, or extension of the fracture being repaired. It is important that a fairly large area of plate in the vicinity of the fracture be heated before the actual work of repair is commenced; the intensity of the heating being gradually tapered off toward the more remote portions of the plate. In the case of a fracture in a stayed portion of plate, as in a locomotive fire-box or the combustion chamber of a marine boiler, the stays in the vicinity of the fracture will have to be removed before

commencing the welding, so as to provide the required elasticity for taking up the movements of expansion and contraction which occur during the heating up and cooling down of the metal. Failure to make this provision may result, not only in additional fractures in the plate, but also in fractures of the surrounding stays, since the atomic forces of the expansion and contraction are well-nigh irresistible. In a few instances, grooving in the front end plates of Lancashire and Cornish boilers has been made up by acetylene welding. In the case of vat ends, efficiently stayed by gussets, there can be no serious objection to this; but the practice is very objectionable where dished ends are concerned, because these have no gussets to strengthen them, the only support being that afforded by the furnace and flue tubes.

Experience seems to show that where old furnaces and flue tubes are concerned, attempts to repair fractures by the oxy-acetylene process often proved more or less unsatisfactory, since there is a tendency for further fractures to break out about the repaired portion in a short time after the boiler has been put to work. Hence, where extensive fractures in old furnaces are concerned, the advisability of making good the defect by oxy-acetylene welding is open to question.

Whether or not repairs effected by the oxy-acetylene welding process will prove satisfactory or not in different cases will always depend to a large extent on the men who carry out the work. These men, in addition to being boiler makers, should be especially trained in the work. To allow inexperienced men to carry out work is courting disaster.

When repairs have been executed, the boiler should be tested hydraulically to a pressure of not less than one and one-half times the stipulated working pressure. This will serve to show in a large measure whether or not the work has been satisfactorily performed. An experienced man will also be able to form a good idea as to the efficiency of the work by hammer-testing the parts.

Bituminous Coal to Anthracite

BY a slow distillation process, the International Coal Products Corp. claims to be able to separate and preserve the semi-volatile elements of bituminous coal, such as oils, pitch and ammoniacal liquor, to utilize the volatile gases for the distillation and for power generation, and leave a dense fuel consisting of fixed carbon with a small per cent of volatile. This product, called Carbocoal, is the result of investigations carried on by C. H. Smith, president of the corporation, and is stated to give rapid steaming similar to semi-bituminous coals with the smokeless combustion of anthracite.

As a feature of the activities of the company, establishment of central power plants near the mines is contemplated, to use the excess gases, and transmit power to industrial centers. Experiments have been under way for a year, at Irvington, N. J., under operating conditions, and it is stated that plans are now being made for the construction of large plants to supply the Carbocoal for domestic and steam users, and to recover by-products for manufacture of explosives and chemicals.

A Chance for Engineers

RESULTS of the work of Canadian and British Engineers in giving comfort and sanitation to the trenches in France where he served for many months were told to the Engineers' Club of Chicago recently by Lieutenant W. G. Masson of the 1st Battery, Canadian Field Artillery. Among other matters, Lieutenant Masson commented on the great reduction in the casualty roll from trench feet, which has come from the introduction by the engineers of trench mats and other devices to keep the soldiers out of the mud. Trench feet, while not usually fatal, unfits a man for further service. During the first winter of the campaign in France, some 60,000 men were thus incapacitated; but during the next winter, although ten times as many men were in the trenches, casualties from trench feet were almost insignificant.

This is part of the work that the engineers are doing. There is something for every man who is in good phys-

LIEUTENANT W. G. MASSON, CANADIAN FIELD ARTILLERY

ical condition, has special technical skill, and wants to help. Engineers of Canadian or British blood can now enlist in either the United States Army or the Canadian or British Armies. Those for the U. S. between ages of 18 and 21 and 31 to 41. Those for Canadian or British forces, the ages of 21 to 45. Details can be had at any recruiting station.

THE PARIS Journal recently published an admonition to the public to burn gas where it could with the following conclusions, which, however, the American reader must analyze and apply for comparison to his own local conditions: "To burn gas will be to economize our coal production. A thousand kilos of coal distilled in a gas retort equals more than 1200 kilos burned in a domestic stove, besides which it has produced 500 kilos of coke, 7.1 kilos of benzol, 9 kilos of sulphate of ammoniaque, 10 kilos of heavy oils or carbure, 1 kilo of phenol."

Some Interesting Figures on Belts*

By W. F. Schaphorst

WE often read about slack belts and their advantage over tight belts, but we seldom see real figures relating to such belts aside from the increased arcs of contact.

The sketch herewith shows how the arc of contact increases with slackness. In some cases, I have known the increase to amount to over 30 per cent, which is considerable and is one of the reasons why a slack belt pulls so well.

The question that remains unanswered is: What change in initial belt tension occurs with the increase of contact? Is that change worthy of consideration?

In the figure, I show a drive that has common, everyday dimensions—30 ft. between shaft centers; a 3-ft. pulley driving a 6-ft. pulley; a belt which is 1 sq. in. in section (equivalent to a single-ply leather belt 4½ in. wide); and I have varied the sag of the slack side all the way from ½ in. to 4 ft.

The enormous change in belt tension is interesting and instructive, as follows:

Sag, inches	Corresponding tension due to weight of belt, lb. per sq. in.
½	1160
1	580
2	290
3	193
4	145
6	97
12	49
24	25
36	17.4
48	13.8

As a little study of the figures will indicate, the tension varies inversely as the sag in an almost exact proportion. That is, $1160 \div 2 = 580$, $580 \div 2 = 290$; $290 \div 2 = 145$ (see 4-in. sag); $145 \div 6 = 24\frac{1}{6}$ (see 24-in. sag); and so on.

A Useful Formula

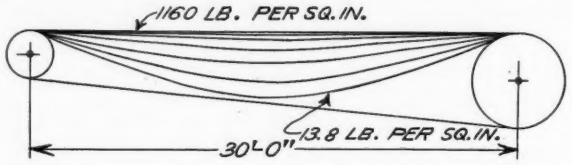
The formula used for solving any tension for any sag, any material (steel cables, electric cables or wires, ropes, suspension bridges, belts, etc.), and with any distance between points of attachment is:

$$\frac{PL^2}{8D} + PD = \text{tension, lb. per sq. in.};$$

where P = weight of the material under consideration 1 ft. long and 1 sq. in. in section. (For leather such as used in belts, P = 0.43, the value used in obtaining the above figures);
L = length of span in feet;
D = sag, measured in feet.

It is hoped that this formula will prove useful to readers in connection with problems of rope and belt drives.

Just off hand I should say that 1160 lb. is too high an initial tension for a 4½-in. belt. You will say so yourself when you figure that it means over 250 lb. pull per inch width of belt whereas we generally figure a useful pull of only 40 or 50 lb. per inch of width for the sake of safety—to "keep the belt from slipping." So, why in the name of common sense, should we permit a tension of 250 lb. per inch of width on the "slack" side in order to get 300 lb. tension on the tight side? The useful pull then is:



BELT DRIVE WITH COMMON DIMENSIONS BUT VARYING TENSION

$$300 \text{ lb.} - 250 \text{ lb.} = 50 \text{ lb.}$$

Traveling at a speed of 800 ft. per min., each inch in width therefore transmits

$$\frac{50 \times 800}{33{,}000} = 1.2 \text{ hp.}$$

No Exaggeration

You will immediately see how I am not exaggerating common drives a bit when you recall the belt rule: "One inch width of single belt running 800 ft. per min. will transmit 1 hp." I have been good enough here to permit one inch to transmit 1.2 hp.

Also, 580 lb. initial tension is too much, and 290 and 193. Why not permit 24 in. sag and reduce the tension to 25 lb.? If it can be done without belt slip, I say do it.

Many a drive is operating successfully today with that much sag, and without slip. In fact, I know of an installation where a 16-in. belt is transmitting 300 hp. at a belt speed of 2340 ft. per min. The tension per inch of width is 265 lb., and yet the belt sags 30 in. If this belt were pulled up tight, figure for yourself how the useful strength of the belt might be wasted.

Bearing Reactions

Besides, there is the bearing friction to consider. The common method nowadays in putting on a belt is to "make a guess" as to the amount of belt to be sliced out, take out "1 in. or so more" for good measure and then force the belt onto the pulleys tight as a fiddle string. We thus get enormously high tensions—much higher than we think.

According to the rule of thumb given above, we can allow 185 lb. "useful pull" on our 4½-in. single belt, indicated in the sketch. With a tension of 1160 lb. on the "slack" side, we must therefore have (1160 + 185 =) 1345 lb. pull on the tight side. The total pull, then, on each shaft, must be at least (1160 + 1345 =) 2505 lb., which is enormous. On the other hand, with a sag of 2 ft. the tension on the slack side is only 25 lb., and on the tight side it is (25 + 185 =) 210 lb. In this case the total pull on each shaft is (25 + 210 =) 235 lb., and just as much or *more* work is being done.

*Copyright by W. F. Schaphorst.

High Transmission Efficiency

We now see why there is such a difference in transmission efficiency. The friction of the slack-belt-bearings is less than 10 per cent of the tight-belt-bearing friction. $235 \div 2505 = 9.4$ per cent. Isn't that worth while?

If you wish to figure the power consumption of your bearings, due to tight belts only, here is a fair formula:

$$\text{Horsepower lost in journal bearings as ordinarily fitted, and well lubricated.} = \frac{0.000{,}367\ d\ W\ N}{33{,}000}$$

where d = diameter of shaft in inches;
W = total belt pull or load on bearing in pounds;
N = revolutions per minute.

You may say: "If a belt can endure a pull of 1345 lb. without breaking prematurely, it should be made to pull its full strength all the time."

There's some logic in that, too, and rather than buy new and larger belts in installations that are being enlarged, I recommend increasing the stress in slack belts as long as they pull easily without slip. It may even be a good plan to install an idler pulley to prevent slip in extreme cases.

All these points tend to prove the advantages of the slack belt. You can usually add more load on them. Tight belts, though, cannot be overloaded.

An Engineer in Service

IT IS some jump from a pipe wrench to a pair of spurs; from an engine room suit to olive drab and from a job as "attending physician" for all kinds of mechanical accidents to that of First Lieutenant presiding over the destinies of the "mule skinner division" of the 121st Heavy Artillery. But "War is Hell," and it is getting heller every day.

If an engineer finds that there are not enough hours in a day, an army officer learns that to keep up with the endless stream of requirements he should have a nine-day week and a sixty-day month.

As you know, I started as a private in Battery C, then was boosted to Top Sergeant, next to Second Lieutenant in Battery F, and now I am First Lieutenant in the Supply Co. of the 121st Heavy. Incidentally, lieutenants are considered expendable,—the same as brooms, baled hay, shells and shoes.

This life is one grand round of routine duties, with a dash of the unforeseen thrown in for good measure. From 6 a.m. to 10:30 p.m. every man has to be at a certain place, doing a certain thing at a certain time,—or somebody is going to come around and ask—WHY? The officers above are looking after my shortcomings, and, naturally, I am passing the buck to the buck privates.

The work as instructor in gunnery in Battery F was very interesting. Those guns are wonderful pieces of mechanism,—only there are no valves to set, and no flywheels to stop at the wrong time and leave her "stuck on the middle." But every time one of those "roarin' Megs" lets go, you think that the boiler has vacated without warning, or a 5000-kw. gas engine has back fired.

This supply company job is strenuous. The chief recommendation of a supply company man is that he can drive four outlaw mules, and urge them to greater efforts by a flow of language that would make Mark Twain's Mississippi River Pilot seem like a post graduate divinity student. We have 27 wagons, 8 rolling kitchens, 4 water wagons (not for passengers), and various other stuff, each drawn by four mules.

Our job is to keep the men of the regiment supplied with grub, clothes, ammunition, etc., besides getting cordwood for the kitchens and forage for 1000 horses and mules. We carry several wagon loads of mail daily, haul freight and express, and between times do anything else that needs to be done around camp in the interest of the regiment. In this respect it much resembles the job of the engineer force in many plants.

Last week we took the wagon train out to the artillery range for two days, and had to pack the wagons for the return trip in the dark, after 6:30 p.m., start home at 8 p.m. without supper and make 19 miles in a cold rain. My left eye was swelled shut and the right one nearly so with some sort of pink eye thing, and the ex-cow pony I rode was moon blind, so it was some job piloting the train home over a strange road. But we got in right behind the troops that marched those 19 miles and got them their blanket rolls and tents so that they could go to bed at just 4 a.m. It is a joyous life! Sherman was right! But then, it's all in the game, and we'll do more than that when we get across.

Last Saturday and Sunday, the Colonel delegated me as "Official Santa Claus" to get a tree and "get it going," as he said. I took a wagon and ten men out three miles where we found a fine tree 30 ft. high, but in the midst of a jungle. We had to clear a path through the underbrush and small trees for 250 ft. to a ravine 20 ft. deep and as wide. We bridged this with a couple of trees, then hitched on 150 ft. of binding rope with four mules on the end and finally got our tree out into the open. That afternoon I went down town, three miles, and brought home more junk than a 10-cent store for trimmings. Sunday we got ten electricians and helpers and trimmed her up as she lay *on the ground,* ornaments and all. There was more than 300 ft. of wire and 6 doz. frosted, 115-v. lights; 120 yd. of red, green, and gold streamers, 6 doz. each of bells and glass balls, besides toys enough to make a real Santa open his mouth. You see, I was determined to "get it going" right.

Then, to raise the tree,—more mules—and a rigging like that to raise a windmill,—and up she went in a 25-mile gale. We had all kinds of help and soon had guy ropes snubbed around stakes: And there she stood, a blaze of glory, visible, they say, for 10 miles out into the country.

A few days ago, I got a glimpse of an engine room out in a little hamlet that covers about as much territory as the side of the Masonic Temple. There was a cotton gin, an old boiler, and an engine that would be about 14 by 20 if the cotton seeds were shoveled off. The exhaust pipe was a section of tin down spout that had been run into by a wagon. There was a fine Phenix cylinder oil pump full of cotton seed (how it came to be there is a mystery); the rod was scored and the crank pit full of seeds, well packed in oil except where the crank had kept a path worn through. At each end of the slide was a pile of caked seeds. Maybe they expect to lubricate with cotton-seed oil. The throttle wheel was loose. Grates were warped like a snake fence. The stack was rusted full of holes. The feed pump was busted and held together

with rods, bolts and straps. If there was any commandment for power plants that wasn't violated, they'll break it when they learn about it.

Thank goodness it isn't in the supply company's duties to take over that plant and operate it,—yet.

GEO. H. WALLACE.

Government Reports on Furnace Experiments

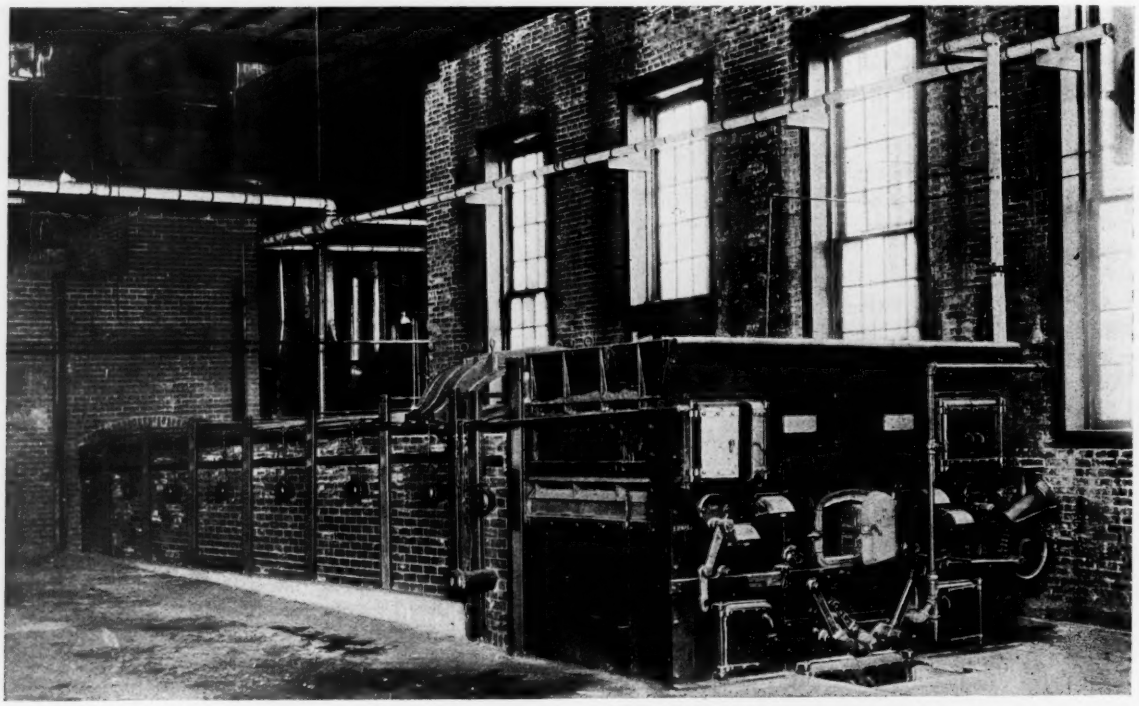
THE Bureau of Mines, Department of the Interior, after several years of experiments in fuel combustion in a special furnace, makes the announcement that from the results it is possible to design a furnace with considerable more assurance as to its capabilities than has heretofore been possible.

Starting with the analysis of the coal to be used and the rate at which it is to be burned, the furnace dimensions in feet and inches can be designed with a reasonable assurance of obtaining a desired degree of completeness of combustion.

The bureau has just made a report on this subject, Bulletin 135, "Combustion of Coal and Design of Furnaces," by Henry Kreisinger, C. E. Augustine, and F. K. Ovitz. The publication marks a period in work approved in 1906 by a National Advisory Board appointed by the president to advise the government concerning fuels. The bureau proposed to conduct such experiments as would make it possible to design fuel-burning furnaces on a rational basis rather than by the cut and try methods of the past. The process carried on in the combustion space is influenced by many factors, the most important of which are the volume and shape of the combustion space; the kind of coal used, especially the character and amount of volatile matter it contains; the rate of firing; the quantity of air supplied over the fuel bed; the rate of mixing the air with the combustible rising from the fuel bed; the rate of heating the coal; and the temperature in the combustion space.

The qualitative effects on the rate and completeness of combustion of many of these factors have been known for a long time; but the quantitative data, presented in definite units, of seconds, pounds, feet, or percentages, have been lacking. To obtain such definite information a study of combustion in the space beyond the fuel bed was undertaken, and the results of extensive tests are given in this bulletin. About 100 elaborate tests were conducted in a special furnace using three kinds of coal—Pocahontas, Pittsburgh, and Illinois—and at rates of combustion covering the full range found in practice. These are believed to be the most extensive tests of the kind ever undertaken.

While the bulletin is especially for those interested in the design or reconstruction of fuel-burning furnaces, it contains much of interest to the general engineer interested in fuel problems. Some of the statements sure to arrest the attention of the interested engineer are as follows:



EXPERIMENTAL COMBUSTION CHAMBER USED BY BUREAU OF MINES IN STUDYING FURNACE DESIGN

The size of the combustion space required appears to be directly proportional to the percentage of oxygen in the moisture-free and ash-free coal.

The percentage of excess air that gives the best results varies with the size of the furnace and the kind of fuel. This fact explains why in one plant the highest efficiency may be obtained with 14 per cent of CO_2 in the gases, and in another plant with only 10 per cent of CO_2.

There is a definite relation for each coal between the excess air supply and the percentage of CO_2 in the furnace gases.

Soot is formed at the surface of the fuel bed by heating the hydrocarbons in absence of air. It is not formed by the hydrocarbon gases striking the cooling surfaces of the boiler. As a matter of fact, only a very small trace of the hydrocarbon gases ever reaches the surface of the boiler. Hydrocarbons that do so are prevented from decomposition by the cooling effect of the contact. The cooling surfaces do not cause the formation of soot; they merely collect soot and prevent its combustion.

It seems that most mechanical stokers are smokeless not because they burn the smoke, but because they burn the coal in such a way that very little soot or smoke is produced. Hand-fired furnaces are smoky because soot is produced in or near the fuel bed, and can not be burned in the limited combustion space of the furnace.

Copies of this publication may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

The Rubaiyat of the Power Plant Man

By C. O. Sandstrom.

(Apologies to O. Khayyam and J. Fitzgerald.)

I

WAKE! For the Sun who scattered into flight
The Stars before him from the Field of Night,
Drives Night along with them from Heaven and strikes
The Power Plant Chimney with a Shaft of Light.

II

Before the sound of the alarm clock died,
Methought a voice from the kitchen cried,
"Your bacon and eggs are prepared within
And the gang from the power plant waits outside."

III

And the boiler-room crew who stood before
The cottage shouted—"Open then the door!
You know how little while we have to stay,
And if late we're docked an hour or more."

IV

Come, fill the cups and in the fire fling
Your oil-soaked waste or the chief will sing,
"Get out of here and be on your way,
You duffer—or your neck I'll wring!"

V

Whether at Harrisburg or Wilmington,
The lubricators with oil overrun,
Covering machines; and oozing, drop by drop,
From guides and pillowblock—falling one by one.

VI

"Each morn a thousand drops fall, you say;
Yes, and where are the drops of yesterday?
Soaked in the floor because you doze:
Wake up!—you'll be canned and chased away!"

VII

Well, let it come! What have I to do
With economy—I don't care a boo;
Let chief and manager bluster as they will:
For saving I get nothing—neither do you!

VIII

A book of adventure, swiped from the frau,
A jug of beer, a loaf of bread—and thou
Beside me—I forget all labor—
Oh, pleasure it were labor enow.

IX

Some for the glories and profits; and some
Sigh for the job of chief to come.
Ah, I'll take what cash I can get and go;
No brain-fag and worry for me, by gum!

X

I sometimes think, when I go to bed,
That now the chief is filling his head,
With the stuff he reads in books,—I swears,
That ain't for me—I'd rather be dead!

XI

And what does he do with the things he learns?
Hollers and roars about the coal we burns;
Talks about combustion—now every one knows
That coal burns by fire—and we fire by turns.

XII

Ah, my boy, fill the cup that cheers
And banishes sorrow, and worry, and fears;
Tomorrow!—Why, tomorrow I will be
In bed—feeling old; like a thousand years.

XIII

At the plant the wise guys who discussed
Amperes and volts so wisely—they are thrust
To the front, with big wages,—their chatter I scorn;
I wish that their mouths were stopped with dust.

XIV

Myself when young did eagerly frequent
Schoolroom and shop and heard great argument
About this and that: but evermore
Came out with less wisdom than in I went.

XV

With them the seed of wisdom did I sow,
But carelessly I wrought to make it grow;
And this was all the harvest that I reaped—
I came with nothing, and with nothing I go.

XVI

Into this plant I came not knowing
The why and wherefor of current flowing,
So they put me to work with oil can and waste,
And warned me to keep the fan a-blowing.

XVII

There were questions to which I found no key;
And schemes through which I could not see:
Much talk of draft intensity
There was—but none of that for me.

XVIII

I'll not waste time in the vain pursuit
Of knowledge that will only cause dispute;
The fellow that wants to may dig and scrape,
Hoping to abandon his overall suit.

XIX

"Ah," but my wife and relations say,
"You really should strive for better pay";
But what's the use when I have no pull—
Besides, don't I get two dollars a day?

XX

Oh, threats of discharge and hopes of rise!
One thing is certain—time really flies;
And what good is theory; it's nothing but lies;
And a man can't learn everything before he dies.

XXI

We are nothing but a moving row
Of dubs and wops that come and go,
While the best paying jobs are always held
By the favored ones,—I have no show.

XXII

Said one smart guy, "You work in vain
Unless you study and take some pain;
No one will pity you when you're broke,
And find it hard to get a job again."

XXIII

Then said another, "You're a peevish boy;
Why don't you get busy and have the joy
That comes from study and the effort made
To increase your knowledge?—it won't destroy!"

XXIV

After a silence another spake,
And said, "You really ought to make
A sturdy effort—your mind's awry;
When times get hard, you'll get the shake."

XXV

So while the boys one by one were speaking,
The chief looked in—for he was seeking;
Said he to me, "Get busy, brother!
Your blower shaft is badly creaking."

* * * * * * * *

XXVI

Indeed the indolence I have loved so long
Has done my credit in this town much wrong:
Has drowned my hopes in a shallow cup,
And sold my reputation for a song.

XXVII

Indeed, though repentant oft before,
This time I was sober when I swore;
And then came hope like Rose-in-hand
And from all bad habits I gladly tore.

XXVIII

So much has booze played the infidel,
And robbed me of all honor—Well,
I wonder often why people buy
The cursed stuff barkeepers sell.

XXIX

Would but some power, ere too late
Arrest the boozer from a sorry fate,
And cause him to live quite otherwise
And all bad habits to obliterate!

XXX

I saved some money and bought some books
And hied myself to quiet nooks;
I studied hard,—when hard times came,
The other fellows got the hooks.

XXXI

As time went by—most beyond belief;
An engineer left on notice brief:
The boss, in order to fill the void,
Promoted me to assistant-chief.

XXXII

And later on when the chief resigned,
I got his place, for I had left behind
Bad habits and indolence, which, to succeed,
Must ever be banished by all our kind.

XXXIII

So, I can with logic absolute,
Whining and envy—all confute;
Who has ambition, can in a trice,
Firemen or oiler to engineer transmute.

XXXIV

They say that Jack and Jim still keep
The bars where you and I drank deep;
And the same old gang can ever be found
Poisoning their brains when they should be asleep.

XXXV

So, my friend, should you ever pass
'Mongst those with feet on the rail of brass,
And in your errand reach the spot
Where I made one—turn down an empty glass!

What the War-Savings Stamps Will Buy for Our Soldiers

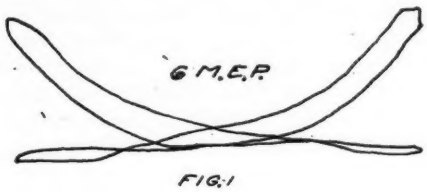
A SINGLE Thrift Stamp will buy a tent pole or five tent pins, a waist belt or hat cord, shoe laces or identification tags; two will buy one trench tool or a pair of woolen gloves. Four Thrift Stamps will buy two pairs of canvas leggings; six will buy five pairs of woolen socks or three suits of summer underwear; twelve will buy a steel helmet.

One War-Savings Stamp will buy one hundred cartridges or a cartridge belt or a scabbard for a bayonet; two will purchase two pairs of woolen breeches or two flannel shirts; two and a half will buy a gas mask; three will buy an overcoat or two woolen service coats; three and a half will buy three pairs of woolen blankets; four will buy a rifle.

Power Required for Excitation

INDICATOR CARDS which show the difference in mean effective pressure before and after building up voltage of a direct connected engine are so rare that I have never yet seen one nor even heard it talked about.

I once had charge of an electric plant consisting of three Ball engines direct connected to Crocker-Wheeler generator, three-wire direct current system, 75 kw., 150 kw., and 200 kw. In indicating these engines first when the engine was up to speed after building up its voltage, I got the cards marked Fig. 1, averaging six



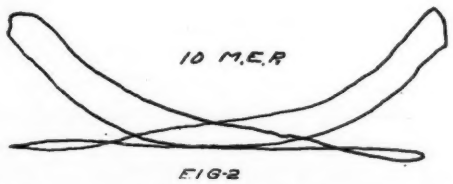


FIG. 1. CARDS TAKEN WITH FRICTION LOAD ONLY
FIG. 2. CARDS WITH GENERATOR EXCITED BUT CARRYING NO LOAD

lb. mean effective pressure. The engine had a horsepower constant of 3.60, which gives 21.60 hp. as the friction load of the engine and generator. My next step was to build up the voltage to 230, but I did not throw in the main switch which would, of course, put this engine on the line with others, so I got cards, Fig. 2, which are perceptibly of greater area, showing a mean effective pressure of 10 lb., giving a difference of 4 lb., which is due to the built-up voltage and this 4 lb. times the engine constant of 3.60, gives 14.40 hp., which, added to the former friction cards equals 21.60 + 14.40 = 36.00 hp., and no amperes showing on the ammeter.

In another plant, one engine was belted to a 125-kw. Wagner alternating-current generator, three-wire, 225 v., and a Crocker-Wheeler exciter, 110 v. Now, with the engine and generators running up to speed and voltage on alternator and exciter built up to 225 and 110 respectively, but no amperes showing on the ammeter. I took six cards and the average horsepower for this friction load was 47. I put the condition up to the builders of the engine to see if they would "dig out," whereupon they informed me that I must have some bad frictional conditions in the engine and generator. I told them that the engine after shutting off the throttle valve would make 128 revolutions before stopping if the safety pin was left in, or 68 revolutions with pin left out. I told them that this didn't look like much unnecessary friction, which they admitted, and gave it up.

On indicating this outfit with no voltage built up, I got a card which showed 7 lb. mean effective pressure, or 23.80 hp., which left a balance of 47.00 — 23.80 or 23.20 hp. to be changed to the generator's voltage. This is not generally known, and is seldom thought of; but it is not necessary to use an indicator unless the exact horsepower is desired, because if the governor position is marked before voltage is built up it will change perceptibly.

A. WALDRON.

Rebabbiting Engine Bearings

A MARINE ENGINEER took charge of a stationary plant containing, among others, a vertical engine driving a blower. One of his first moves was to remove the cylinder lubricator from this engine, as he did not consider

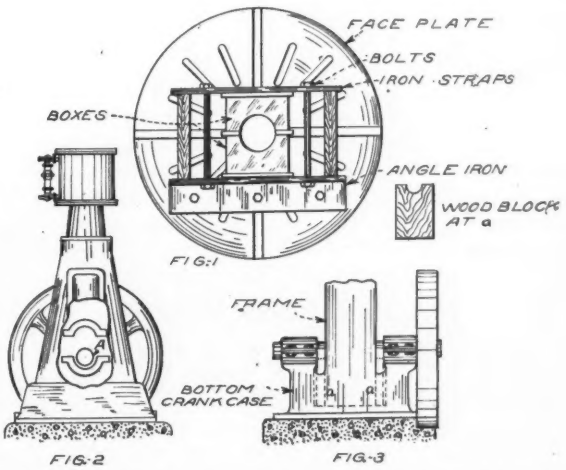


FIG. 1. MANNER IN WHICH BOXES WERE SECURED TO FACE PLATE
FIG. 2. END VIEW OF ENGINE FRAME WITH CRANK SHAFT AT A
FIG. 3. WOODEN BLOCKS USED TO SUPPORT SHAFT AND THEIR METHOD OF APPLICATION

it necessary to use oil in the cylinder since it was not done in marine work even on large engines.

The result was that the metallic packings on the valve stem and piston rod were subjected to excessive wear, allowing the condensed steam to run into the crank case making an emulsion with the oil that the pump could not handle; as a consequence the crankpin and main bearings burned out, thus requiring rebabbiting.

Inside and outside calipers showed that the crankpin boxes would contain a thickness of babbit of only 1/16 in. so they were strapped onto an angle iron which in turn was secured to the face plate of a lathe as shown in Fig. 1. The boxes were bored out to allow for 3/16-in. of babbit on each side of the pin.

Holes to anchor the babbit were drilled in the shells. An arbor was turned of wood ¼ in. smaller than the crankpin, which was carefully centered in the boxes and the metal poured.

The boxes were again mounted on the face plate and bored out to the diameter of the crankpin, the metal being kept wet with kerosene. The oil grooves were cut and the boxes fitted to the pin by scraping.

Figure 2 shows an end view of the engine frame with the crank shaft at A.

Supporting the arbor in its proper position in the bearings was accomplished this way: The diameter of the shaft and the bore of the main bearings being found the thickness of babbit required was obtained as 0.5 the difference in the measurements. Two pieces of wood were cut as shown in Fig. 3 with a semicircle cut in one end equal to the diameter of the shaft, the arc of the semicircle being at such a distance from the flat end of the block as would represent the position of the shaft above the bottom of the crank case.

One block was put on each side of the frame at the inner end of the main bearings and securely stayed. The shaft was chalked and allowed to rest in these blocks as cradles. The shims were put back, the caps bolted on and the ends of the bearings sealed with putty, the metal being poured into the bearings through the oil holes in the caps.

When cold, the caps were removed, oil warp cut and the bearing surfaces scraped to fit the shaft.

When all was assembled and new oil placed in the crank case, the engine was slowly started and gradually increased in speed to the maximum. When the bearings showed no further signs of heating, the shims were removed. RECEIVER.

Mysterious Knock Remedied

IN THE PLANT where the writer is employed as one of the engineers, considerable trouble had been encountered with a peculiar knock seemingly in the shaft governor. The other engineers said that they could find no place or sign by which a knock would be produced in the governor, but still the "knock." There was not lost motion in any of the parts of the governor, as all had been taken out previously; it was well lubricated and kept clean; in fact, everything which the average engineer would resort to, to remedy or prohibit a knock had been done, and still the "knock."

As I had just started in to work for this company, I listened to the various stories and began to study the symptoms of the case myself. At first, I was of the opinion that the springs on the governor were vibrating and to try them for the knock I wrapped them with a sleeve made with a 2-in. rubber hose laced about each spring. On starting up, the knock presented itself as usual, so I knew that the springs had nothing to do with it. Further studying the sound and tracing it to its seeming source, I noticed that the noise was similar to pulling a large cork out of a large bottle. Upon this theory, I laid the cause to the belt and four large countersinks in the rim of the wheel. The machine used was a 150-hp. Ball Engine which is of the shaft governor high-speed type, belt driving an 85-kw. a.c. generator. The springs of the governor were held in place by rods which had one end secured by being upset and set in sockets or countersinks in the rim of the wheel, the other end, of course, being attached to the spring. As the belt swept over these holes in the rim, a certain amount of air was ejected and tended to form a partial vacuum between the belt and the holes. Therefore when the belt was leaving the rim, the suction and quick departure of the two caused the popping noise which we hear when we eject a cork from a bottle suddenly. There were four of these holes, each about 2 in. in diameter and an inch deep, the bottom of each being filled with dirt and practically air-tight. By driving four wooden plugs into the four holes and leaving the surfaces perfectly flush with the rim of the wheel, I found that after starting up, the mysterious knock had disappeared, and concluded that the holes in the rim and the belt had been the cause thereof.

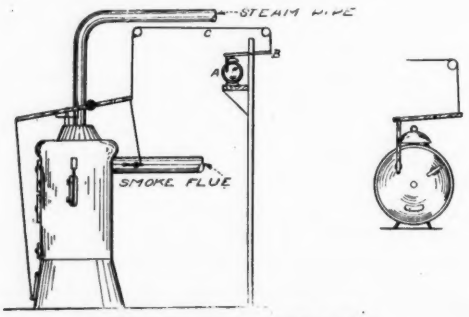
In using very pliable or oily belt, be sure that there are no pits or sockets in the rim of the wheel, as similar trouble may occur and no amount of governor or other adjustment would remedy the disagreeable noise.

NORMAN EWING.

Draft Regulation of House Heating Plant

NO DOUBT many engineers have a steam plant at home for house heating. I have a low-pressure outfit in my basement and have made some changes in regulation of the draft that have saved me many pounds of coal.

As originally installed, the damper regulator was connected to a tilting damper in the ash pit door and to a



AUTOMATIC DRAFT REGULATOR

damper in the side of the smoke flue. As the pressure rose in the boiler, the tilting damper in the ash pit door was closed. Any further increase in pressure opened the damper on the side of the flue and would admit air to check the draft. There was also a hand operated damper in the smoke flue. I have connected this

to the damper regulator and now all three dampers are operated automatically.

At night the fire is banked and by means of a device constructed on the principles of a box trap the damper regulator is hooked up and is tripped in the morning by means of an alarm clock at any hour I wish.

THE CHIEF.

Safety in Boiler Operation

LOOKING OVER back numbers of Power Plant Engineering, I noticed a discussion on what to do when convinced that a boiler was not safe to operate. Young runners may find this a troublesome affair. The boss will generally insist on running, provided the boiler will hold water. Now is the time for the engineer to be either man or mouse.

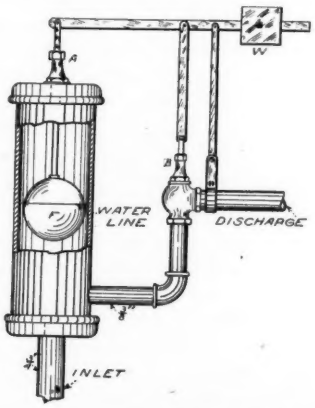
In Ohio we have state license and boiler inspection. This is as it should be and gives the engineer the privilege of calling in the state inspector. Of course, if he over-rules you, it is your next move (out); but it is better to be safe than sorry, and the inspector's information is worth seeking.

I have had about all the trouble with boilers to be had, except explosion, and have very little trouble with owners when I order a boiler off the line.

Remember, your license advertises you as a safe man; don't fail to live up to it. J. C. LEE.

Readily Constructed Steam Trap

THE LOW-PRESSURE TRAP shown here is made entirely of scrap. The float chamber is a piece of 4-in. pipe, 18 in. long. The float is a seamless copper toilet float. Stuffing box A on top of the chamber was taken from a worn-out ⅜-in. globe valve. In this case, the threads on the bonnet were the same as ⅜-in. pipe threads, but it could be soldered or brazed into place if one did not possess the proper size tap. The threads were filed off



LOW PRESSURE STEAM TRAP

the stem of the angle valve on discharge, so that it would slide freely in stuffing box B. No packing is needed here, as the pressure is on the bottom of the valve. Stuffing box A should be packed lightly and the nut screwed up with the fingers only. The position of counterweight W can easily be ascertained by a little experimenting. If all the moving parts are made out of light material, a counterweight may not be necessary. The trap should be set 2 ft. or more below the apparatus to be drained.

I have used this trap to drain an exhaust separator and a low-pressure header for over a year and have had absolutely no trouble with it. It works perfectly at any pressure up to 10 lb. and drains all the water, without permitting any steam to escape.

J. W. ESHNAUR.

Relocating Marks on Wristplate

THE PROBLEM of re-locating marks on wristplate of vertical engine as propounded by E. B. P., in Jan. 15, issue, I noticed is receiving considerable attention, but as yet I have not seen the methods suggested that are really employed by a trouble man. You would not relocate marks on a horizontal engine that was designed properly by lengthening or shortening eccentric or reach rods. Neither do you do so on a vertical type.

On the horizontal engine, a plumb dropped through center of wristplate bearing and reachrod pin gives the center of throw of wristplate.

Also the same plumb dropped through rocker-arm center gives the central position of the rocker arm. One cannot drop the plumb line through these points of a vertical engine, yet the plumb line may be dropped

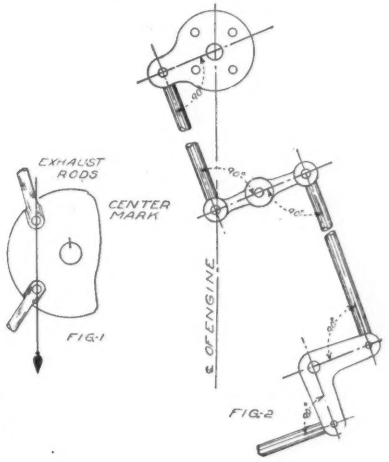


FIG. 1. PLUMB LINE DROPPED THROUGH EXHAUST ROD STUDS

FIG. 2. DIAGRAM OF VALVE GEAR SHOWING ANGLE OF RODS WITH ROCKER ARM, BELLCRANK, ETC.

through the exhaust or steam studs as indicated in Fig. 1 with a nice degree of accuracy, and this point will be the place to lay out the center mark.

In the sketches on page 185 of Feb. 15 issue, the reachrod stud appears to be misplaced; i. e., it could hardly be mechanically correct were it exactly between the two valve-actuating studs, as the angle of the rod would make an uneven travel.

When wristplate and rod are midway of travel, a perfect right angle should be formed and this also holds true of all similar connections.

In Mr. Mason's sketch, the angle formed, looks good; but when gear is shifted, it will be seen that mid travel will not be a 90-deg. angle.

In Mr. Ringle's sketch, the wristplate is set properly, but the rocker arm is not properly balanced as the angle formed is much more than 90 deg., and as I stated before the reachrod (rod from rocker to wristplate) stud on the wristplate is in the wrong place. Perhaps this is an error in E. B. P.'s drawing, and the original pin is O. K.

If the simple rule of leg, base and hypotenuse is used, it will be an easy matter to balance all rocker arms, regardless of their position. In the following example of the rocker-arm on the engine in question; turn to center of travel, determined by eccentric, put prick punch marks on rod as far as convenient from stud center, now square said distance, add square of distance from center to center of rocker studs and extract square root; see Fig. 3.

If distance as measured by tram is not 30 in. the rod must be lengthened or shortened to equal 30.

If bellcrank is designed properly, the eccentric and reachroads will both make a right angle or practically so if extended when eccentric is at half position—remembering that the angularity of eccentric rod is always taken into consideration.

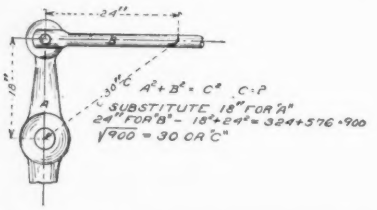


FIG. 3. DIAGRAM OF ROCKER ARM AND CALCULATIONS

If the valve gear is designed properly as I stated before, this method of balancing rocker arms should rarely ever fail, only in cases where short eccentric rods are employed, and then the eccentric must be placed in both midway positions and marks verified. I have seen valve gears improperly laid out so that it would be impossible to square or balance both rods.

TOM THUMB.

Use of Steam Flow Meter in an Industrial Plant

THE WRITER recently conducted a series of steam tests to be used as a basis for distributing steam and power costs in an industrial plant of 2200 b.hp. The steam consumption of the engines was obtained from indicator cards and a steam flow meter was used to measure the steam used in heating and manufacturing processes.

The power costs were thus equitably distributed among the various departments. There was also valuable data obtained which proved as useful for other purposes as cost distribution.

In one department there were two batteries of machines performing the same kind of work and one battery was found to be using nearly twice as much steam as the other. This led to an investigation; the leak was discovered and remedied. This saving alone was enough to cover the cost of the tests.

Another department had 10 heaters which were run in pairs. It was customary to start one and sometimes two pairs at the same time. The tests showed that when a heater was started it took steam at the rate of about 100 b.hp. for the first 15 min. and this gradually decreased to about 10 b.hp. at the end of an hour, after which it was constant to the end of the run. Four heaters started at one time thus caused a load on the boilers about 25 per cent of their capacity. By arranging to start the heaters at intervals of not less than 30 min., this objectionable peak was eliminated.

G. A. G.

Unusual Use of Vacuum Pump

IN THE PLANT where I am employed, we have a vacuum heating system. Exhaust steam is used at 2 lb. pressure. The end of each coil is equipped with a thermostatic trap set to close at 21 deg. F. We have a number of hydraulic presses on which steam was carried at 40 lb. pressure and a portion of the discharge was used in a press for the manufacture of our goods with the rest blown out to waste. We wanted to get these presses connected to the vacuum pump, but a large heating and ventilating concern in a near-by city said it could not be done successfully. However, by placing the traps far enough away from the presses to allow the water to cool sufficiently we have accomplished the desired results. We now steam our stock with exhaust steam from the pumps and find it takes 20 min. where, by the old method, it took 1 hr. We have reduced the pressure on the presses to 20 lb. and obtain a lot of clean hot water for boiler feed. My share? A raise of $150 a year.

THE CHIEF.

Cause of Worn Cylinder

REGARDING the trouble of J. D. C., as related on page 223 of the March 1 issue, relative to cylinders wearing larger at the ends than in the center, this will often happen when using certain styles of steam packing and will be more noticeable on Corliss than on slide-valve engines. On a Corliss, the cutoff is more abrupt. I have seen small holes drilled in piston heads to admit steam underneath the ordinary snap ring; this would have a tendency to wear the cylinder more at the end than in the center. JAMES BENNETT.

Soot Problem

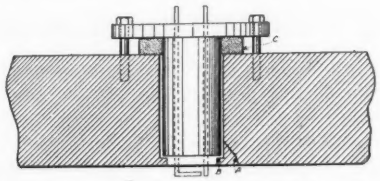
WITH REFERENCE to the trouble of E. R., as related on page 223 of the March 1 issue, I wish to say that I have had very satisfactory results removing soot by the use of compressed air instead of steam, which is more or less moist. If the reservoir in which the air is stored is kept drained, the air will be dry, thereby enabling it to cut the soot more readily. The air used is maintained at a pressure of about 90 lb. gage.

A. J. W.

THINK OF COAL MINES HAVING to shut down for lack of coal! Scores of mines in Central Pennsylvania operate with electric current furnished by the Penn. Central Light and Power Co., and the company officials say that the plant will shut down if coal cannot be procured.—Compressed Air Magazine.

Emergency Gas Engine Repair

IN A PLANT of which I am in charge, there is one 13 by 14-in. Westinghouse gas engine. The head is cracked, as shown by dotted lines at A, and B is the joint between the head and igniter. The crack being back of the joint, allowed considerable leakage around the igniter casing, causing it to heat badly. I had a



RING USED TO PREVENT LEAKING AROUND IGNITER

⅜ by ½-in. ring made, as shown at C, with a driving fit on the igniter case, then used a copper gasket between ring and cylinder head. The engine gave me no more trouble. R. B. R.

A Few Kinks

HAVING NEED of an extra pipe vise, and noting a large size discarded valve bonnet about the boiler room, one of our firemen proceeded to make an improvised vise, as shown in Fig. 1. It serves its purpose excellently.

Figure 2 shows how to make use of a pair of old snips.

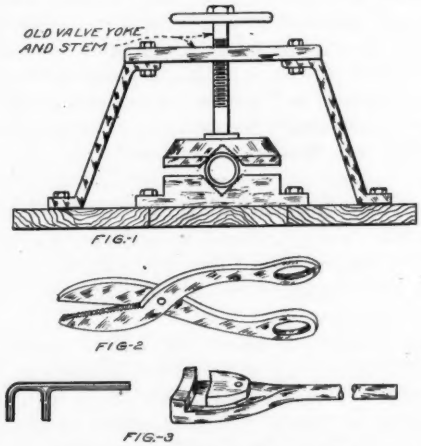


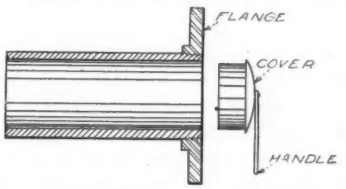
FIG. 1. IMPROVISED PIPE VISE
FIG. 2. PACKING SHEARS
FIG. 3. HANDY VALVE WRENCHES

The lower jaw was annealed and serrated with a file, and then re-tempered. These made fine packing shears, the serrated jaw holding the packing while the other jaw does the cutting.

Figure 3 illustrates two types of valve wheel "Samsons" that aid in starting large size valves off their seats. After a valve has been shut for a considerable length of time, and the change of temperature takes place between its live and dead sides, the valve disc and stem contract to the seat, and it is generally necessary to use additional leverage on the hand wheels when starting them open again. C. H. W.

Keep Packing Chips Out of Pipe

THE SKETCH illustrates a pipe and flange with a separate cover to insert into pipe while scraping or cleaning the old packing off pipe flange. Many engineers are well aware of the trouble, annoyance and expense of having drip valves, check valves, strainers and other



PIPE END COVER

valves put out of commission from the above and cover for the various sizes of pipes can be easily and cheaply made by almost anybody. JOHN M. LEICH.

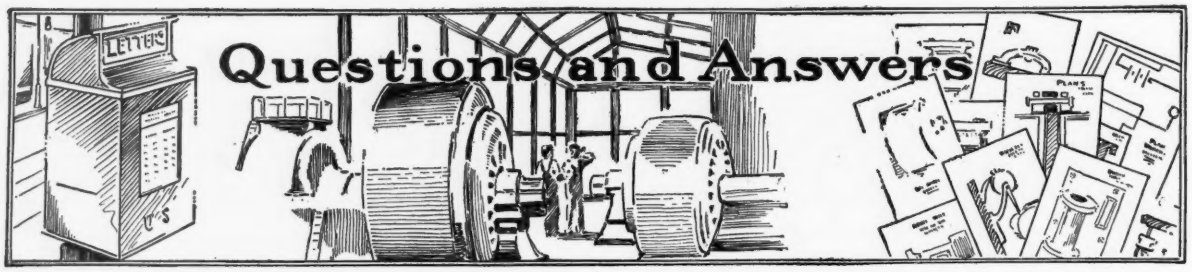
Insulated Ladders and Stools

THE ACCOMPANYING illustrations show how I have equipped all of the step ladders and stools used for working on wiring and all electrical apparatus. By fitting them with glass insulators in the manner indicated,

BY FITTING STOOLS AND LADDERS WITH INSULATED FOOTINGS DANGER FROM ELECTRIC SHOCK IS REMOVED

possibility of which is entirely removed, especially when working on concrete or damp wooden floors or the ground. C. C. SPREEN.

PERISCOPES HAVE been installed in a power plant recently for the purpose of reading the temperature of the oil in transformers. Previously this required the use of a ladder. Why not apply the device to water gages, flue gas thermometers or other instruments in out of the way places?



Suitable Frequencies for Long-Distance Transmission

WHEN IS IT ADVISABLE to install a plant of a lower or higher frequency than 60 cycles per second? What frequency plant should be installed on a transmission line twenty-five to fifty miles long for the best results, and why? V. K. S.

A. A higher frequency than 60 cycles is not at present used to any extent in this country. In the early days, on alternating-current work, a frequency of 132 cycles was used, largely because the machines were made up on nearly the design of the double current machines. The objection to high frequency is that it increases quite a good deal, the hysteresis and induction losses in generators, transformers, motors and transmission lines.

Sixty cycles is the standard of practice for short transmissions and for local distributing systems. This is found to give a reasonable amount of hysteresis and induction loss, and, at the same time, does not produce a flicker in incandescent lights which is noticeable.

For very long-distance transmissions, the 25-cycle frequency is used, in order to reduce the induction loss in the transmission lines and the loss in transformers, as such losses become rather large in connection with the large amount of power sent over long-distance lines.

The objection to 25-cycle frequency is, that if current is used at this frequency on incandescent lighting circuits, there is a perceptible flicker of the lights which is unpleasant. Also, where these long-distance lines feed into local systems already established, most of the motors and transformers of the local system are being installed for 60 cycles, and the expense of changing over all this system to 25-cycle apparatus would be very great. It is customary, therefore, to install at the local distributing station a frequency changer—which is merely a rotary converter—for changing 25-cycle current to 60 cycles.

The question of whether to use 25 or 60 cycles becomes merely one of balancing the losses from induction and hysteresis in the transmission line and transformers against the investment and loss in the rotary converter for changing the frequency from 25 to 60 cycles at the distributing station.

For 25 miles—unless the amount of power transmitted is very large—it is doubtful whether it would pay to generate at 25 cycles and then change to 60 cycles. For 50 miles, it is probably about on the dividing line. If the amount of power is considerable, it would pay to generate and transmit at 25 cycles and change to 60 cycles for use.

If there is a composite system, where new apparatus is being installed throughout—a part of the transmission 25 miles and part of it 50 miles—it might be possible to use the 25-cycle transmission throughout and install all apparatus for 25 cycles. There would be some flicker on the incandescent lights, but if people had never had the 60-cycle lighting, this probably would not be sufficient so that there would be any great amount of objection.

Cooling Compressor Cylinders and Stuffing Boxes

I WOULD LIKE to know your opinion about liquid ammonia injection for keeping compressor and stuffing box cool. Is it profitable to do this or frost back from brine tank? Would it be safe to drill and tap a 1-in. tee for ¼-in. pipe and drill and tap side of suction valve which is 1½ for same size? I am using metallic packing and must keep stuffing box cool. H. W. S.

A. Liquid ammonia injection to keep the compressor cylinder and stuffing box cool is a usual and economical method of accomplishing the result. It is probably better, on the whole, than frosting back from the brine tank, although there is no objection to the latter if the distance from the brine tank to the compressor is not too great.

We would think it unwise to drill and tap a fitting or valve to take out ammonia line. It is almost impossible to get a threaded joint of this kind which will hold against ammonia pressure for any length of time. The proper method would be to put a cross in, in place of the tee, and take your outlet from the other opening in the cross, and to put in a tee one side or the other of the valve, and make the connection to this tee, using regular ammonia fittings at all points.

Steam Calculations

WILL YOU kindly inform me what is the factor of evaporation under the following conditions? Steam pressure, 168 lb. gage; feed-water temperature, 143 deg. F.; steam superheated, 20 deg. F.

I would also like to know if by adding a superheater it is possible to increase the factor of evaporation?

The reason I ask the last question is, in figuring a boiler test in the data of which the above figures appear, a certain person has added to the temperature of steam at gage pressure the degree of superheat.

I think this incorrect because all formulas for finding the factor of evaporation read $\frac{H \times h}{970.4}$, in which H is the B.t.u. in steam at gage pressure, and not at the temperature of superheated steam. I have always under-

stood that steam is superheated, not to increase the factor of evaporation, but to obtain a drier steam and save loss due to condensation. I find, however, that in the test by adding superheat you increase the factor of evaporation. J. A. H.

A. The factor of evaporation depends on the total heat in the steam, whether it be saturated or superheated. When steam is superheated, more heat is added than would be in the steam if it were saturated only, and this additional heat must be taken account of in figuring the factor of evaporation.

The only satisfactory way to figure this factor is from a set of tables on the Properties of Superheated Steam, since the specific heat of superheated steam varies with the pressure and with the temperature of superheat.

In the case that you give, 168 lb. gage pressure and 20 deg. F. superheat, this would be equivalent to 183 lb. absolute, and the total amount of heat in the steam, under those conditions, would be 1209.4 B.t.u. The heat in the liquid at 143 deg. F. is 110.89 B.t.u., and the difference will be 1098.51 B.t.u. This divided by 970.4 gives a factor of evaporation of 1.1320.

The formulas that you find for the factor of evaporation are all based on the use of saturated steam. The form of the equation for the factor is correct; but where superheated steam is used, H must be understood as the total amount of heat in a pound of superheated steam, including both the heat to make saturated steam and that used in superheating.

Preventing Detrimental Effect of Steam Pipe on Floor Covering

IN THE KITCHEN of a large institution where we do the repair work there are five large stock (or soup) kettles, having steam feed, steam return, waste and water feed connections to and from each. These kettles are located on stands, which rest on a floor of some asbestos composition. The trouble appears to be, that the heat of the pipes, passing through the floor to the kettles, has caused the floor to crack and curl up around the point where the piping passes through the floor. The floor is laid on a concrete foundation and the piping is protected from coming in contact with the floor by iron sleeves. The steam pressure when kettles are in use is generally 75 lb., as the line feeding the kettles is connected direct to the boiler header. We have been advised to replace this part of the floor under the kettles with red tile, but before doing so would greatly appreciate any advice you would care to give on the subject. F. M.

A. There is no question but what the red-tile floor around the steam pipes will be satisfactory in staying in place. Probably no floor made of any sort of vegetable material, or of any material which will absorb moisture will be satisfactory, as you will have the heat from the steam pipes drying the upper surface which is next to the air, more than the under surface next to the concrete, and this will cause warping and curling.

If appearance is not too much of a consideration, it is probable that you could surface the floor around the steam pipes with neat cement mortar, made up of one part of sand and one part of cement, well troweled down and then surfaced with a coating of pure cement. The surface could then be painted with any one of several kinds of paint specially made for concrete floors, and would be proof against the effect of the steam heat. It will not make as good-looking a job, however, as the tile, and, of course, the tile can be satisfactorily laid in cement mortar, as you know.

The separating of the pipes from the floor by iron sleeves would not have very much effect in preventing curling, since the heat from pipes carrying 75 lb. steam would radiate sufficiently to produce the drying and curling of the floor. The only object of the separation by iron sleeves is to prevent any possibility of charring in case of a wooden floor.

Capacity of Air Compressors

I HAVE an Ingersoll-Rand high-pressure electrically-driven air compressor. The dimensions of this machine are as follows: High-pressure cylinder, 20¼ by 24 in.; low-pressure cylinder, 32 by 24 in. The speed is 167 r.p.m. I would like to know how many cubic feet of air this compressor can deliver per minute.

E. J. C.

A. The formula for finding the capacity of an air compressor is as follows:

$$\frac{0.7854\ d^2\ L\ N \times VE}{1728} =$$

capacity in cubic feet of free air per minute in which d is the diameter of the low-pressure cylinder in inches. L is the length of the stroke. N the number of strokes per minute and VE the volumetric efficiency. Working this out from your problem we find that it is 3705 times the volumetric efficiency. The volumetric efficiency depends largely upon the clearance space at the end of your cylinder, the speed of your compressor and the type of valves employed. It will range all the way from 80 to 95 per cent. Assuming that you have 90 per cent volumetric efficiency, your compressor would have a capacity of 3345 cu. ft. of free air per minute approximately.

Boiler and Condenser Questions

WHY IS a B. & W. boiler set on an incline?

2. If a hole appears in a barometric condenser, what is the result?

3. In a battery of four boilers, which has the best draft, and why? E. O. L.

ANSWERS

The B. & W. boiler is not set on an incline, but the tubes are inclined toward the headers, for the purpose of bringing an easier upflow to the water and helping the circulation. The water passes up in these inclined tubes to the steam drum, where steam is liberated, then from the front of the boiler to the back and down in the vertical tubes at the back.

2. A hole in the barometric condenser, if it comes in the condenser head, will, of course, tend to reduce the vacuum and decrease the amount of condensing water drawn up. If it is large enough, it may destroy the vacuum entirely. Ordinarily, the water is drawn into a barometric condenser by the vacuum in the condenser. The vacuum is created by the downfall of the

water in the tail pipe. If the hole is in the tail pipe, it will allow air to draw in and mix with this column of falling water, and will, of course, decrease the vacuum in the condenser head.

3. With a battery of four boilers, the best draft will naturally be on the boiler nearest the chimney, as the draft will be reduced on the other boilers by the amount necessary to overcome the friction of the smoke pipe. Frequently it is attempted to overcome this somewhat by using a tapered smoke pipe which is larger near the chimney than at the far end, thus tending to reduce the friction of the gases in the pipe.

Machine Parts Nomenclature

IS THE TERM "tap bolt" correct?

2. Kindly explain whether a cap screw with a nut size head would be considered a cap screw or whether it would be known as a machine bolt with a hexagon head?

3. Kindly give a general description of the above-mentioned cap screw as to finish, size, etc. D. A. M.

ANSWERS

THE TERM "tap bolt" is entirely correct, and refers to a bolt with hexagon head, having the thread running practically clear up to the head.

2. As to the cap screw with nut-size head, whether it would be a cap screw or a machine bolt with a hexagon head, would depend on the length of the thread. If the thread is the ordinary short thread, it would be a machine bolt. If it had the thread from ½ to ¾ of the length, it would be a cap screw. I presume you are familiar with the difference between the heads of cap screws and machine bolts under ordinary conditions. The cap screw has a head somewhat larger than the machine bolt.

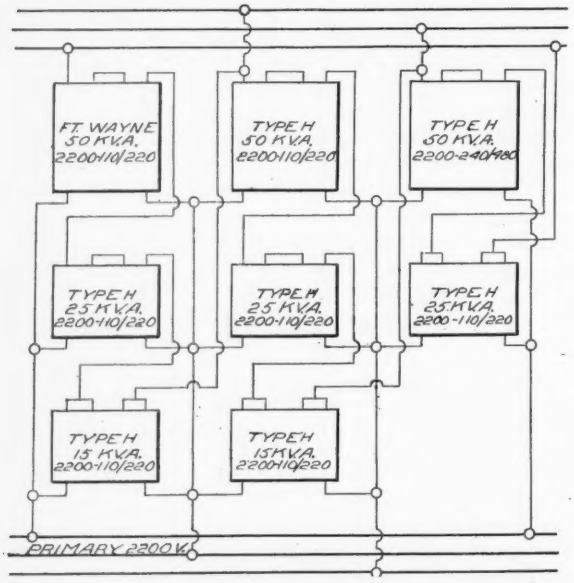


FIG. 1. GENERAL ARRANGEMENT OF TRANSFORMER BANKS

3. We do not quite understand what you want in your third question. The ordinary cap screw is finished all over, and for sizes up to 1 in. diameter by 4 in. long, has the thread running up ¾ the length of the the body. For larger sizes the travel runs ½ the length of the body. The head is usually of the same thickness as a bolt head, but slightly larger. There are a good many cap screws made to special specifications, where the dimensions vary from these.

Unique Three-Phase Transformer Connections

IF A SET OF TRANSFORMERS are connected as shown in Fig. 1, what will be the resultant secondary voltage or voltages? These transformers are to be used on a 2200-v., three-phase line and have a ratio of transformation of 2200 to 110 and 220; they are to serve a 550-v. three-phase motor. L. L. P.

A. The low voltage connection of Fig. 1 is shown diagrammatically in Fig. 3 with the delta open. The voltages are shown in Fig. 3.

Phase I, 550 v.; Phase II, 550 v.; Phase III, 590 v. If, now, the delta be closed, there will be a large circulating current within the delta.

The impedance of the transformers are not given, but we may assume the following values: For 50 kv.a., 1 per cent IR and 3 per cent IX; for 25 kv.a., 1.5 per cent IR and 3 per cent IX; for 15 kv.a., 1.3 per cent IR and 2.5 per cent IX.

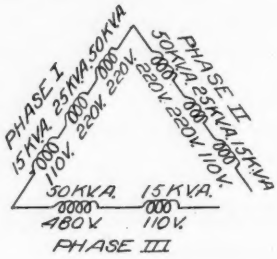


FIG-2

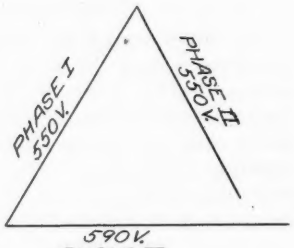


FIG-3

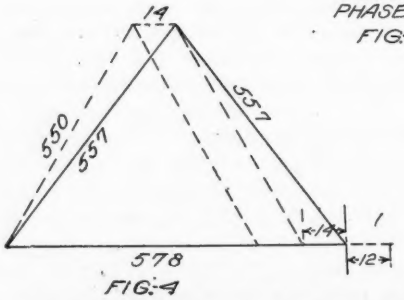


FIG-4

FIG. 2. DIAGRAMMATIC LOW VOLTAGE TRANSFORMER CONNECTIONS

FIG. 3. DIAGRAM OF VOLTAGE

FIG. 4. DIAGRAM OF PHASE VOLTAGES

On this bases there will be about 100 amp. circulating current in the delta and the phase voltages will be as shown in Fig. 4 (heavy lines).

The circulating current is very nearly the full load current for the 25 kv.a. unit; the connection is, therefore, inadvisable.

The proper connection to use would be to leave out the transformers in phase III, and run phases I and II open delta. The characteristic of this connection is that the power factor within the transformers is 86.6 per cent.

The rated current of the transformers are as follows:

Unit	Connection	Current
50 kv.a.	220 v.	227 amp.
25 kv.a.	220 v.	113 amp.
15 kv.a.	110 v.	136 amp.

Evidently the bank cannot carry more than 113 amp. without overloading the 25 kv.a. transformer.

At this current and 550 v., unity power factor load, the total output will be $\frac{2\ (113 \times 0.866)}{1000}$ kv.a., that is, 108 kw., or 145 hp.

The division of the load will be as follows:

Unit	Actual Load
50 kv.a.	$(113 \div 227)\ 50 = 25$ kv.a.
25 kv.a.	$(113 \div 113)\ 25 = 25$ kv.a.
15 kv.a.	$(113 \div 136)\ 15 = 12.5$ kv.a.
	62.5 kv.a.
	$62.5 \times 2 = 125$ kv.a.
	$125 \times 0.866 = 108$ kw.

General Electric Co., Engineering Department.

Calculating Tank Capacity

I have a storage tank the height of which is 12 ft., the diameter of the upper section 10 ft. and that of the lower section 12 ft. What is its cubical contents?

R. E. R.

A. The tank is really nothing more than an truncated cone, having a height of 12 ft., an upper diameter of 10 ft., and a lower diameter of 12 ft.

In order to obtain the mean diameter of this tank, it is necessary to take the sum of these two diameters and divide by 2, or, in other words, $(10 + 12) \div 2$, or 11 ft.; squaring this and multiplying the product thus obtained by 0.7854, we have $11^2 \times 0.7854$, or 95.03, as the number of square feet of the mean section of the tank. Multiplying this, in turn, by the height, or 12 ft., gives us a total volume of 1140.36 cu. ft.

Alternating-Current Generator Calculations

Kindly give me a formula by means of which I can calculate the number of poles required for any alternating current generator, showing the number of frequencies per second and the speed. G. M.

A. Consider first a two-pole machine. With each revolution of the armature one cycle is completed so that if there are a number of revolutions of the armature made per second, there will be n cycles per second. If, however, the number of pairs of poles be p, then the frequency f will be equal to the product of the number of pairs of poles by the number of revolutions per second, or $f = p\ n$.

Transposing and solving for n we have $f \div n$ or the number of pairs of poles equal to the frequency in cycles per second divided by the number of revolutions of the armature per second.

Water Flow Through V-Notch Weir

Will you please give me the formula for figuring the flow of water through a V-notch weir.

R. L. M.

A. The formula for a sharp-edged pitch is:

$$Q = C\ (4/15\ l\ h\ \sqrt{2\ g\ h})$$

where l is the width of the notch a distance h above the vertex, and C is a coefficient with a value of from 0.57 to 0.60, based on experiments with heads up to 3 ft. and vertex angles of 28, 60, 90, and 120 deg. The coefficient 0.57 was found for the 60 and 90 deg. weirs, and 0.60 for the 28 and 120 deg. weirs.

In the above formula, Q is the number of cu. ft. per sec., and g is the value of gravity. O. H. H.

Diesel Engineers

In looking through the the pages of different power plant publications, it seems to me that there is a lack of correspondence from engineers operating oil engines, both Diesel and semi-Diesel. What is the reason? Don't they ever have any trouble, or are they all too modest to write? I'll bet that the experience of some of them would fill a book as large as the old-time school dictionary if they would just take the time to put them in book form.

My experience with a Diesel engine has been of all kinds and I thought I had bumped up against about every kind of trouble that there is, but I found that I was mistaken when one day the engine suddenly developed a case of what the superintendent called the "butts," or in other words a hunting governor. The governor has perfect control of the engine when it once gets settled down, but the cutting off of a 30-hp. load will start the governor arm to swinging from no load position to full load, and it will take from 5 to 10 min. for it to settle down to normal.

If any of the readers of Power Plant Engineering ever had any experience like this, perhaps they can tell what causes the trouble. C. W. R.

For sealing small cracks in the boiler setting a good paint can be made as follows: 10 lb. Trinidad asphalt; 1 gal. benzine; 7.5 lb. Portland cement; 7.5 lb. mixture of 85 per cent magnesia and 15 per cent asbestos. Heat the asphalt to the consistency of paint. Mix the cement and magnesia-asbestos and heat in an oven to 300 deg. F. Remove the asphalt to a safe distance from the fire and mix in the benzine thoroughly; then add the cement and magnesia-asbestos compound and stir to a uniform mass. Keep the benzine away from the fire.

The paint should be applied hot with a 4-in. brush, and brushed well into the cracks. Two light coats are better than one heavy coat. Immediately after applying the last coat, cover the fresh paint with a coating of sand by throwing forcibly against the painted surface.

One application should maintain an airtight surface for a year.

Officials of the Westinghouse Lamp Co., of Bloomfield, N. J., have appealed to Federal food authorities for 35 lb. weekly of brown sugar, stating it would be necessary to suspend operations in the company's plant unless the request was granted. It was explained that brown sugar is used in infinitesimal amounts in the manufacture of electric globes.—Compressed Air Magazine.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.
(Established over 22 years.)
Formerly PRACTICAL ENGINEER.
PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

BY THE TECHNICAL PUBLISHING CO.
537 South Dearborn Street,
CHICAGO, ILL.

New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1918, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Circulation of this issue, 23,550

CONTENTS

Cincinnati's New Source of Electric Energy Supply. Illustrated 271
Pump Sizes for Vacuum Heating Systems. By M. William Ehrlich 276
System in the Power Plant. By J. C. Hawkins. Illustrated 277
Coal and Its Selection. By Haylett O'Neill. Illustrated.279
A Power Plant Regiment....281
Water Power in Congress....281
Powerful Electric Locomotives. Illustrated....282
Inductance of Conductors in Conduit. By R. H. Earle...283
Saving Electricity by a Steam Boiler. Illustrated....283
Increasing Power Plant Economy. By C. T. Baker. Illustrated 284
For Cleaner Coal 285
Boiler Repairs by Oxy-Acetylene Welding. By Mark Meredith 286
A Chance for Engineers. Illustrated....287
Some Interesting Figures on Belts. By W. F. Schaphorst. Illustrated 288
An Engineer in Service. By Geo. H. Wallace....289
Government Reports on Furnace Experiments. Illustrated 290
The Rubaiyat of the Power Plant Man. By C. O. Sandstrom 291
Letters Direct from the Plant: Power Required for Excitation. Rebabbiting Engine Bearings. Mysterious Knock Remedied. Draft Regulation of House Heating Plant. Safety in Boiler Operation. Readily Constructed Steam Trap. Relocating Marks on Wristplate. Use of Steam Flow Meter in an Industrial Plant. Unusual Use of Vacuum Pump. Cause of Worn Cylinder. Soot Problem. Illustrated....293
Successful Kinks from the Power Plant. Illustrated....297
Questions and Answers. Illustrated....298
Editorial: Hiring and Holding Men. Cincinnati's New Power Station. Women in Power Plant Work....302
Coal Distribution for 1918-19....303
Knowledge by the Pound. By George E. Bowen....304
Reverse Current Relays. Illustrated....305
Large Noiseless Pinion. Illustrated....305
News Notes 305
Book Reviews 306

Hiring and Holding Men

One of the biggest problems at present is to keep an effective organization. There is a tremendous incentive for men to meet the needs of the country by going into active service, either in khaki or in direct manufacture of war supplies. But the power plants must be kept running or the factories will be of little use.

For those who are keeping their organizations in the power house intact, there is an opportunity for service to their fellow plant managers and the country by telling others how they do it.

Those who have had to replace men who have gone by volunteering or into the National Army can help by telling how they pick new men to fill the vacancies, and how they keep them.

The subject is important, for changing men frequently is costly, especially in a calling where so much depends on expert knowledge and experience.

Will you do your fellow craftsmen the favor to send in your methods, giving in detail any tests you use for the fitness of applicants, bonuses or rewards for good accomplishment and special recognition for continued service in the plant?

Also, what safeguards, if any, do you find it necessary to employ, at present, against hostile or mischievous employes?

This is a chance to do a real service to the industry of the country, and to get help from the practice of others. Let's have your letter about your way of doing things.

Cincinnati's New Power Station

To one interested in power plant engineering, a visit to the new West End Station of the Union Gas & Electric Co., Cincinnati, O., now in course of construction, will reveal a number of unusual features, some necessitated by local conditions, others desirable from the standpoint of economy and a higher degree of operating efficiency. Of the former, the most striking example is the method employed to secure an abundant and continuous supply of water for condensing and boiler feed purposes and the arrangement of the condensing apparatus within the deep well housings constructed for that purpose. Ordinarily, it is desirable to place the condensers in as close proximity to the prime movers they serve as is possible; but due to the excessive pump suctions which would have been necessitated by adhering to this practice, it was undoubtedly deemed more economical to contend with the comparatively smaller losses bound to be occasioned by the employment of a long exhaust line.

The coal and ash handling systems, we believe, will be the simplest ever installed in a plant of this size and type. Making proper allowances for expenditures required for the construction of the indoor coal storage bins and the added boiler costs due to the individual bunkers, it is reasonable to expect, with the elimination of large overhead bunkers and the extra heavy steel work required for their support and a more or less complicated system of conveying apparatus, that not only will the initial cost of this end of the plant be considerably less than otherwise, but that the costs

of operating this system will be maintained at a minimum figure.

Some may object to the obstructed firing aisle; but where mechanical stoking is employed and where each row of boilers is in charge of a set of operators whose duties require them to give their undivided attention to the units to which they are assigned, there appears but little justification in such objections, considering the many benefits accruing otherwise from the employment of this system.

The heaviest operating expense for both coal and ash handling systems will undoubtedly be that in connection with the operation of the crane. Dumping of the coal cars and the operation of the ash pit valves will require but the simplest kind of day labor.

Another radical departure from current central station design is the location of the switch house above the turbine room. Placing it so has made it possible not only to improve the exterior architectural lines of the building, but has resulted in a decided saving of ground space and costly foundations. This scheme, wherever employed, has the added advantage of allowing extensions to the turbine room in directions otherwise made impossible on account of independent and isolated switch houses. In addition, the savings to be realized in costs of electrical construction between the machines in the turbine room and the switching apparatus, must be considered.

Women in Power Plant Work

In America, we are in the habit of classifying work as a woman's or a man's work. Of course, there have been many cases where people have stepped out of their usual classification and been successful, but about the last place we would expect to find women working is in power plants. Analyzing the present labor situation, however, it would not be surprising to find companies conducting classes of instruction for women in the details of operation of some power plant apparatus.

The work about a power plant that is open to women is found more in large plants, for here the duties are usually assigned to those who have specialized along certain lines and may not necessarily be familiar with the operation of all machinery in the plant.

Such work, for example, as keeping records of power plant operation, reading meters, thermometers, etc., all kinds of clerical work, analyzing fuels, water and oils, tending to flue gas analysis instruments, weighing coal shipments, caring for storage batteries, and tending switchboards can be performed by women as well as, if not better than, by men. To this list may be added other duties of a more mechanical nature which in routine operation do not require great physical strength, such as operating electric cranes, maintaining proper stoker adjustments and draft conditions or attending feed pumps. This work could all be done by women with proper training and physical qualifications.

For any of this work the women selected should have at least the equivalent of a high school education in physics, chemistry and mathematics.

That women are being employed more and more in semi-technical positions is evidenced by the fact that the General Electric Co. is conducting a school for training women college graduates for positions in its sales departments, research and testing laboratories.

Coal Distribution for 1918-1919

REGULATIONS are announced by the Fuel Administration for retail distribution of coal for the year beginning April 1, 1918. Purchases and shortage of coal and coke for domestic use as early as possible will be encouraged. As an inducement, a reduction on anthracite will be made, April 1, of 30 cents a ton for all coal purchased between April 1 and September 1.

Retail dealers will be required to report on deliveries, and prohibited from delivering in excess of the normal requirements of the customer, who must submit a statement of his needs, giving the supply on hand, the amount he has ordered from various dealers, the amount used in the 12 mo. ending Mar. 31, 1918, and the amount needed prior to Mar. 31, 1919. False certification of such a statement is subject to prosecution and severe penalties.

No customer will receive more than two-thirds of the yearly amount called for of anthracite until all customers who have ordered, and are willing to accept it have received their two-thirds supply, except that orders for 6 T. or less may be delivered in full. After all have received two-thirds of their requirements, further deliveries will be made until each customer has received his full supply.

Orders for bituminous coal will be filled in full.

Carload or bargeload lots will be delivered to a single domestic consumer or a group of consumers only by permission of the local fuel administrator.

An order of the Administration also establishes prices at the mine for certain western coals. Colorado bituminous, domestic, run of mine, $2.25; prepared sizes, $3.50; slack or screenings, $1.25. These prices are subject to reductions as follows: April 1, 70 cents; May 1, 50 cents; June 1, 35 cents; Aug. 1, 15 cents. For bituminous steam coal, Trinidad district, the prices at the mine are: run of mine, $2.35; prepared sizes, $3.25; slack or screenings, $1.65; subject to reductions as follows: April 1, 40 cents; May 1, 30 cents; June 1, 20 cents; July 1, 10 cents.

For lignite, the prices are: run of mine, $2.25; prepared sizes, $3.25; slack or screenings, $1.

These prices do not include 45 cents a ton allowed to operators who have raised wages in compliance with the Washington agreement.

Prices for Montana, Wyoming and Utah coal are uniform as follows: Run of mine, $2.65; prepared sizes, $3.30; slack, $1.50.

These prices also do not include the 45 cents a ton allowed to such mines as have complied with the terms of the wage agreement.

TO CLOSE large cracks and small holes in brickwork, first ram in asbestos, rope or old pipe covering, to fill the opening. Then seal over with a flexible cement made of 10 lb. asphalt, 10 lb. magnesia-asbestos, 10 lb. Portland cement, ½ gal. benzine. Heat the asphalt until fluid; remove from the fire and mix in the benzine, then stir in the cement and magnesia-asbestos, already mixed and heated to 300 deg. F. If the surface to be sealed is subject to high temperature increase the proportion of cement and magnesia.

Knowledge by the Pound

By George E. Bowen.

THAT notorious legislative blunder known as *The Postal Zone Rate Bill* has opened the eyes of Americans to the first and most important cause of our national greatness—the equally widespread knowledge of human events and conditions of life, accomplished through the beneficent agency of the public press.

The public school and the public press—twin sources of intelligence.

Can we maintain one and destroy the other?

If, as people, we have been blind to the value and significance of our national integrity; to the unity of thought, purpose and service that has justified our claim to superior enlightenment and compelled world recognition of it, the program of the *Postal Zone Rate Bill* has shown us the danger of sectional divisions, (either of law or literature), and pointed out what public calamity would follow the compulsory dislocation of common knowledge by the full operation of Congressman Kitchins' *Bill of Restraint of Reading.*

It has been left for an American Congress, in the year 1917, to subject knowledge to avoirdupois measurement and regulate its distribution by the grocer's scales, a yardstick—and our individual ability to pay the unequal sectional rate.

Intelligence is to enjoy the same postal classification and distinction as butter, bacon, codfish and calico.

America has much to learn in many ways. Her eager acceptance of the fact proves the excellence of her ambition, already expressed in unequalled material achievement and in educational progress duplicated by no other nation.

Much of America's skill and wisdom have been provided and encouraged by the magazine and periodical press.

Publications seriously and intelligently devoted to every phase and branch of our communal life—education, art, science, industry, commerce, civic progress, health, agriculture and the home—continually inspire new ideals, finer service and more worthy citizenship.

Hand in hand with intelligence go the blessings created by it—the tools, toys, provisions, comforts, necessities, adornments, luxuries and refinements of our civilization.

All of them *advertised things,* required and demanded by our national development for its maintenance and improvement.

And as magazines and periodicals have, in their instructive, enlightening way, created interest in the things that make up this modern life of ours, the producers of these things go to meet that wonderful and growing demand, through the same agency that created it—the magazine and periodical press.

Could anything be more rational, practical and consistent—or efficient?

Unlike a book,—a history, grammar or arithmetic—which occupies a fixed position in the home, school or library, and which sets forth for all time its accepted array of standard, established facts, a magazine is a versatile, frequent, continuously engaging expression of progress, of change, of new or advancing ideas, keeping pace with, or leading the march of human events.

The message of a national magazine is not addressed to an isolated group of persons in a fenced-in or barred-out locality.

The service and existence of a magazine are based on popular approval and support. It has no other reason for being or serving.

Through the favor of universal custom, the magazine is enabled more freely to circulate by the amount of its advertising patronage.

A magazine's place of publication is dictated by geographical accident or business circumstances; but its impartial voice goes out with reassurance, enlightenment and inspiration to the farthest coast line, to the last frontier, saying always: "I bring you knowledge, entertainment, new strength, good cheer."

The rules of commerce can never arbitrarily be made into avoirdupois laws extending or restraining intelligence.

An electric lamp may be sold; but not the radiance it bestows in dark places.

No electric light corporation, however grasping, has as yet seen profit in blindfolding portions of the public to its general illumination. Such a thing may come to pass—by congressional order.

But while seeking to secure the proportionate welfare of the publisher, advertiser and reader, let us not forget the real burden bearer—the Postoffice Department.

We cannot underfeed or abuse our faithful packhorse.

If advertisers fully make up the 8-cent fourth class rate, in their contracts with publishers, the publishers then must have reason to feel and be liberal with the Postoffice Department.

All of which, fairly is a matter of adjustment, of equalization.

While practice and profit push theory aside, it must be admitted that modern advertising, *per se,* has other than purely commercial value to the magazine reader.

Advertising is not just a list of prices, a display of designs. Good advertising, typical of the age, is highly and frankly informative, a directory of all civilized requirements—and so, knowledge.

Especially is this true to the magazine reader, where the advertising is distinctly or even indirectly related to the subjects in the reading section of his magazine.

Although paid for and published as "advertising," the *instructive and art value* of many high-class advertisements must be freely conceded.

Everybody knows that often there is much information of public value in the advertising section of a magazine as well as in the "editorial" pages.

True enough, private profit and public welfare sometimes find it perplexing and difficult to agree upon a basis of equal mutual advantage, but no one representing the real interests of either side will dispute the old belief that "knowledge is power," or the other one about "a house divided."

If we must have knowledge by the pound, let us, as Americans, have it on equal terms.

Reverse Current Relays

A NEW form of reverse current relay has been developed by The Automatic Reclosing Circuit Breaker Co. These relays are of the circuit opening type and are so designed that the relay will open either upon reversal of current, or with zero current at abnormally low voltage.

The relay is closed and held closed by a shunt polarizing coil with which is connected in series a high resistance. To close the relay, a push button switch is provided which temporarily short-circuits the high resistance. The high resistance limits the current in the shunt winding to a value just sufficient to hold the relay closed. A reversal of current or failure of voltage will thus cause the relay to open.

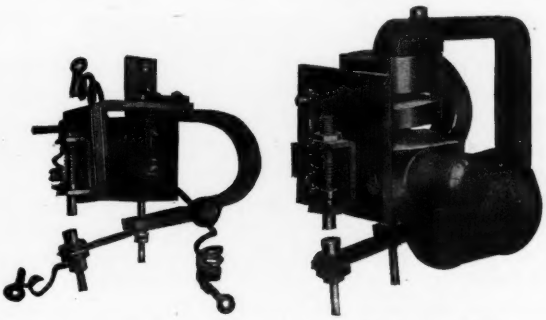


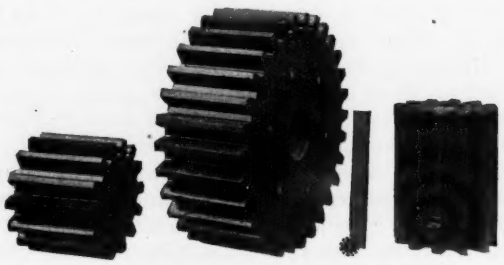
FIG. 1. REVERSE CURRENT RELAY — 1200 TO 2000-AMP. SIZE

FIG. 2. REVERSE CURRENT RELAY — 400 TO 800-AMP. SIZE

These relays are designed for mounting on rear of circuit breaker panel. The 1200 and 2000-amp. sizes have a magnetic yoke which surrounds the upper stud of breaker. The 400 and 800-amp. sizes are provided with a series winding one terminal of which is connected directly to the upper stud on rear of panel.

Large Noiseless Pinion

AN interesting example of what may be accomplished with Bakelite Micarta-D gear is shown by the gears in the accompanying illustration. As will be seen by comparison with the foot rule at the right of it, the pinion in the center is 21 in. in diameter and has an 8-in. face. It is designed to transmit 100 hp. at 425 revolutions per minute. One of the particular features of this pinion, in addition to its large size, is the fact that no metal shroud was employed, or needed.



BAKELITE MICARTA-D GEAR

Bakelite Micarta-D gear material is a product of heavy duck bonded together with Bakelite by heating while under an enormous pressure. It is unaffected by atmospheric changes, cannot be destroyed by rats, is vermin-proof and can be stored indefinitely without shrinking or other deterioration. It can be used for gears that have to operate in oil, without any signs of swelling.

News Notes

THE ORDNANCE DEPARTMENT of the Government is in need of civilian workers, largely for inspectors' positions, and for this work men with a high-school education and some training are desirable. They will be specially trained for the work under Government instructors, and those having the required technical training will be placed and advanced as quickly as their ability justifies. Inspectors are desired for ammunition steel, cartridge cases, powder and explosives, forging operations on cannon, gun carriages and parts, gun fire control instruments, motor vehicles and artillery wheels, ammunition packing boxes; also engineers and assistant engineers for tests of ordnance materials, and machinists who are accustomed to working to 1000ths of an inch. No applications will be accepted from persons already in government service, unless accompanied by written assent of the head of the concern by which the applicant is employed. Further information may be had from C. V. Meserole, U. S. A., Room 800, 79 Wall St., New York City.

LOYALL A. OSBORNE, of New York, Vice-President of the Westinghouse Electric & Manufacturing Co., and chairman of the executive committee of the National Industrial Conference Board, has been appointed, by the Secretary of Labor, a member of a committee on industrial peace during the war.

This committee, which consists of five representatives of employers, five labor leaders, and two public men, will provide a definite labor program in order that there may be industrial peace during the war, thus

preventing interruption of industrial production vital to the war.

CHARLES R. THOMPSON, Master Mechanic for The Universal Ship Building Co., 1513 Rush St., Houston, Texas, is desirous of receiving catalogs from manufacturers of all kinds of power house equipment.

A. F. AUSMAN, formerly vice-president of McMaster-Carr Supply Co., of Chicago, has accepted the position of district manager of the Nagle Corliss Engine Works, of Erie, Pa., for the Chicago district, and will have offices in the Monadnock Block.

THE PERMUTIT CO., manufacturers of water softening and water rectification apparatus and for several years past located at 30 East 42nd St., New York, announces its removal to 440 Fourth Ave., New York, where the entire top floor is occupied by its offices.

WORTHINGTON PUMP & MACHINERY CORPORATION, of New York City, reports the following changes and appointments in its administrative force: James E. Sague, Vice-President in charge of Engineering and Manufacturing; Leon P. Feustman, Vice-President in charge of General Commercial Affairs; Frank H. Jones, Vice-President in charge of Sales; Wm. Goodman, Assistant to Vice-President; Wm. Schwanhausser, Chief Engineer; Edward T. Fishwick, General Sales Manager, and Charles E. Wilson, Assistant General Sales Manager. The offices of the above appointees will be at 115 Broadway, New York City. Neal C. Lamont has been appointed as Works Manager, Laidlaw Works, with office at Elmwood Place, Cincinnati, Ohio.

Book Reviews

STEAM POWER PLANT ENGINEERING, by George F. Gebhardt; New York; fifth edition, 1057 pages, 6 by 9 in.; illustrated; price $4.00.

Gebhardt's Steam Power Plant Engineering has grown from a college textbook with some practical information for the engineer in the plant, to a reference book of invaluable aid to the power plant engineer in selecting equipment, designing the plant, running tests of various machinery, and maintaining economy in everyday operation. Although this fifth edition is rewritten from former editions, the same style of treatment has been followed except that the information of everyday use in the plant is given much more space in proportion to theory, which fact will be appreciated by the majority of its readers. Particular stress has been laid upon fuels and combustion, and supplementary chapters on elementary thermodynamics, properties of steam, and properties of dry saturated air have been added.

Following is a list of the subjects treated in different chapters and appendixes which show the extent of the work:

Elementary Steam Power Plants; Fuels and Combustion; Boilers; Smoke Prevention, Furnace, Stokers; Superheaters; Coal and Ash-Handling Apparatus; Chimneys; Mechanical Draft; Reciprocating Steam Engines; Steam Turbines; Condensers; Feed-Water Purifiers and Heaters; Pumps; Separators, Traps, Drains; Piping and Pipe Fittings; Lubricants and Lubrication; Testing and Measuring Apparatus; Finance and Economies—Cost of Power; Typical Specifications; Typical Central Stations; A Typical Modern Isolated Station; Properties of Saturated and Superheated Steam; Elementary Thermodynamics—Change of State; Elementary Thermodynamics of the Steam Engine; Properties of Air—Dry, Saturated, and Partially Saturated; Data and Results of Evaporation Test; Data and Results of Steam Engine Test; Data and Results of Steam Turbine or Turbo-Generator Test; Data and results of Steam Pumping Machinery Test; Data and Results of Steam Power Plant Test; Miscellaneous Conversion Factors; Equivalent Values of Electrical and Mechanical Units.

THE PERCENTAGE of total available coal recovered in the process of mining is a factor of increasing importance under the present conditions when the demand for fuel is so abnormally high. Under the belief that the percentage of extraction at present is too low, especially in the mining of bituminous coal, the Engineering Experiment Station of the University of Illinois, in co-operation with the Illinois State Geological Survey and the U. S. Bureau of Mines, has undertaken an investigation of the subject and has made a somewhat elaborate study of the facts and information compiled. The work has been done under the immediate direction of Professor C. M. Young of the Department of Mining Engineering at Urbana and the results are published as Bulletin 100 of the Engineering Experiment Station.

The facts developed show that mining methods in many districts of West Virginia and Pennsylvania are yielding, under comparable conditions, a much higher percentage of extraction than those employed in the Illinois, Indiana and Western Kentucky field. It is shown also that there is an excellent opportunity to improve conditions in the Middle West field by more systematic methods of mining.

Copies of Bulletin 100 may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

PLANE TRIGONOMETRY, by Eugene H. Barker; Philadelphia, 1917; 172 pages, 6 by 9 in.; illustrated; price $1.

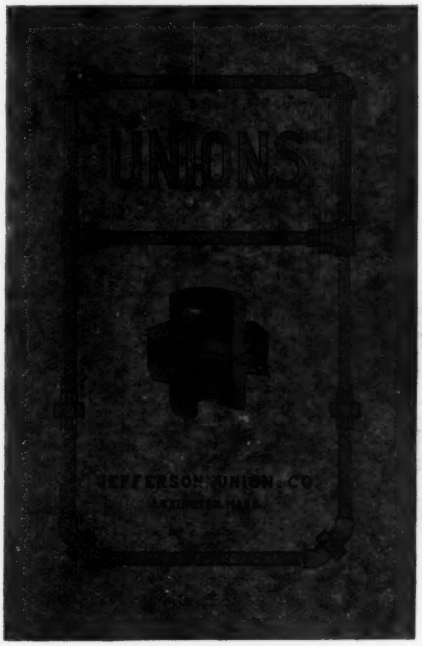
This textbook is evidently for those beginning the study of higher mathematics. It carries the reader logically step by step through the subject of plane trigonometry without needless discussions, yet omitting no essentials. At the end of each chapter is a set of problems which are mostly abstract, but in many cases present practical conditions for solutions. The author states in the preface that greatest endeavor has been made to give the reader thorough familiarity with trigonometric functionality, acquaintance with the interdependence of functions, a knowledge of the methods of trigonometric analysis, power of initiative in the development of formulas, and a certain definite resolute skill in their application to the solution of practical problems.

The book contains a chapter on logarithms and closes with a number of tables which are convenient in the solution of problems.

Catalog Notes

FOSTER VALVE SPECIALTIES Catalog No. 30 illustrates and describes Foster pressure regulators, pump governors, fuel oil stop and check valve, boiler feed water regulator, automatic non-return stop valve and many other classes of valves. The manufacturer is Foster Engineering Co., Newark, N. J.

JEFFERSON UNION CO.'S Catalog A, whose cover design is illustrated herewith, contains 32 pages giving complete information regarding Jefferson unions, union



pipe fittings and flange unions. The catalog also shows by halftone illustrations the different styles of unions and the various operations in Jefferson union making.

A BOOKLET GIVING Army and Navy Insignia, the distinguishing marks of officers and branches of service, and including revised proverbs (If Germany Wins), by George Ade, is being sent out by Greene, Tweed & Co., 109 Duane St., New York, N. Y. A complimentary copy of this booklet will be mailed promptly to any reader of Power Plant Engineering on request.

FROM JOHN W. COWPER CO., Fidelity Bldg., Buffalo, comes a book on Industrial Plant Construction, which contains much information of interest and value to those who may be interested in the building or re-arranging of plants. This deals with the different questions which should be considered in the arrangement of a plant, both as to the factory side and the power plant end, and shows the construction of various types of single story and several story standard factory buildings, and also illustrates a few of the plants designed and constructed by the company during the past 3 yr. It is a book which engineers will find worth having in their files.

A NOTABLE PUBLICATION is the first Anniversary Portfolio of the Magnesia Association, under the general title, Let 85 Per Cent Magnesia Defend Your Steam. The book is a large and impressive assemblage of all the educational publicity regarding this insulation which has been appearing continuously during 1917 in many technical papers. It is a series of careful presentations of the nature and applications of 85 per cent Magnesia as the efficacious and durable insulation for steam pipes and boilers. The educational value of these scientific advertisements in their sequence is of such worth as to entitle the book to a place in the files of engineers, architects, and extensive users of steam. If any interested reader has not received this Portfolio, a copy will be sent him upon his writing to the Secretary of the Magnesia Association of America, 702 Bulletin Building, Philadelphia, Pa.

GRAPHIC RECORDS and the Executive is the title of a circular illustrated by a sample chart and relating to the portable switchboard and wall type pressure and vacuum recorders of The Esterline Co., Indianapolis, Ind.

MARINE OIL ENGINES made by Fairbanks, Morse & Co., are described and illustrated in that company's catalog, 125 B. Other types of oil engines are described in Catalog 92C and Bulletins H192C and H188E.

OPERATION OF K & J. all steel automatic air dump cars for fuel and ash handling, is described in a booklet from The Kilbourne & Jacobs Mfg. Co., Columbus, Ohio.

WILLIAMS' "AGRIPPA" tool holders are described and illustrated, together with price lists, in a 28-page booklet published by J. H. Williams & Co., Brooklyn, N. Y.

Trade Notes

THE ELECTRIC Hoist Manufacturers' Association, has by a resolution adopted at its last meeting, offered the services of the member companies to the government in meeting the extraordinary demand for their product.

The War Industries Board of the government has requested full information concerning the ability of the Electric Hoist Manufacturers to handle the volume of business offered them, as well as what effect priority orders and embargoes on shipments have had upon the trade.

It is evident that the Association will be of great assistance to the War Industries Board, as it is becoming more apparent from day to day that there are numerous advantages for all concerned to have manufacturers in certain lines organized, especially now, in the hour of the nation's greatest need, and instead of vindictive competition and antagonism along business lines, the spirit of co-operation and exchange of ideas, looking toward increased output, should prevail.

Electric hoists for shop use and handling material have gone through various stages of development during the past 15 yr., and like all classes of shop machines, they cannot be successfully designed on the basis of theory alone. Actual experience in meeting hoist requirements and innumerable corrections and refinements in design on the part of the manufacturers have marked the progress made during these past 15 yr. in this important field.

Now that it is thought that the experimental stage has been well passed and acceptable designs developed by various manufacturers, it seems wise to co-ordinate the total experience and to make available for the user, all that is best in electric hoist design and practice. With this object in view, the manufacturers of the United States organized "The Electric Hoist Manufacturers' Association," comprising the following companies: The Brown Hoisting Machinery Co., Detroit Hoist & Machine Co., Euclid Crane & Hoist Co., The Franklin-Moore Co., Link-Belt Co., Roeper Crane & Hoist Works, Shepard Electric Crane & Hoist Co., Sprague Electric Works, The Yale & Towne Mfg. Co.

The officers of the Association are as follows: F. A. Hatch, chairman, Shepard Electric Crane & Hoist Co.; F. W. Hall, vice-chairman, Sprague Electric Works; C. W. Beaver, secretary-treasurer, The Yale & Towne Mfg. Co.

The Association holds monthly meetings for the purpose of studying the specific needs of the hoist user and to develop standardized methods of presenting information to him so that guess work will be eliminated.

The Association will consider uniform nomenclature pertaining to types and parts of Electric Hoists, fix upon a standard by which hoist motors shall be rated and promote the standardization of electric hoists as far as possible. It will also collect and disseminate information and statistics relative to the electric hoist industry, provide facilities and opportunities for study and education in regard to the economics of the industry, extend the use of their product by pointing out the great number of material-handling problems of different classes that can be solved by the use of electric hoists, promote a friendly intercourse and co-operation among the members and disseminate information that long experience has taught is essential to any hoist to insure good results and to recommend to the members of the Association well-established principles, both as to construction and equipment, that will tend to eliminate the possibility of inferior equipment.

The membership of the Association is confined to those engaged in the manufacture of monorail Electric Hoists, which have revolutionized the handling and transportation of material in and about industrial plants.

THE PITTSBURGH Service Department of the Westinghouse Electric & Mfg. Co. has moved from its former location on Amberson Ave., to new quarters at 6905 Susquehanna St., in the Homewood district of Pittsburgh. Express and freight should be consigned to East Liberty, Pa., via P. R. R.

The Automobile Equipment Service Department has also moved to the new location.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.

(Established over 22 years.)

PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

SUBSCRIPTION RATES

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill.

Member Associated Business Papers.

Member Audit Bureau of Circulations.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

DISPLAY ADVERTISING RATES

Full page, one year, each insertion, $66.00.

Half page, one year, each insertion, $38.50.

Quarter page, one year, each insertion, $22.00.

Eighth page, one year, each insertion, $13.25.

Front cover, $175.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Three line parallel 3-point border rule used.

Stippled plates used, but no heavy, black and white plates.

CLASSIFIED ADVERTISING RATES

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy and cuts should be received at Chicago Office eighteen days prior to date of publication.

Circulation of this issue, 23,550.

Technical Publishing Company

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By engineer experienced with producer gas and oil engines, a.c. and d.c. equipment, pumps, storage batteries, interior wiring and repair work. Technical graduate. References. Address Box 501, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 1-1-1

POSITION WANTED—By experienced fireman and engineer who has had charge of waterworks plants, and effected saving of half the coal bill by overhauling the plant. Familiar with electrical work. Address Box 507, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-1

POSITION WANTED—Power station draftsman, electrical graduate, experienced in power and substation layout work. Six years in present position with large manufacturing concern. Desires change. Address Box 511, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 3-1-2

POSITION WANTED—By a practical high- and low-pressure pipe fitter. Age 35 years. Would like to become connected with reliable concern as general pipe fitter or foreman. Address Box 512, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 3-1-4

POSITION WANTED—By a competent electrician and engineer; 34 years of age; married; strictly sober and energetic. Willing to take complete charge of electric light plant or will take charge of power installation or operation. Present salary $150. Desire change with larger opportunity. Address Box 515, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 3-15-1

POSITION WANTED—As chief engineer, 13 years experience with Corliss and high-speed engines, electrical and refrigerating machinery. Sober and reliable. Best of references. Address Box 518, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill., 4-1-1

POSITION WANTED—By middle aged man and chief engineer's license. Can handle d.c. and a.c. machinery, steam boilers, gas and oil engines. Also experienced in wiring and repair work. Address Box 508, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-1

POSITION WANTED—By an engineer with 13 years' experience with boilers, engines, electrical and refrigerating machinery. Wishes to connect with a permanent, reliable concern. Am familiar with flue gas analyzing instruments and furnace efficiency methods. Address Box 509, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—A competent refrigerating engineer in Western Pennsylvania. Must be familiar with raw water and ice making system and electric machinery. State salary wanted. Address Box 505, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—A good fireman to take charge of shift in central station, 1680 hp. of Stirling boilers, chain grate stoker. Address Box 519, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-1-2

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial to put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 hp. to 250 hp. The Pittsburg Boiler & Machine Co., Pittsburg, Kan. tf.

WANTED—Agents handling engine and boiler room specialties in every section of our Boiler Girth Seam Protector. Liberal inducements. Give experience and territory covered. Address National Boiler Protector Co., Dayton, Ohio. tf.

WANTED—Kelley's Engineer's Examiner. Anyone having a copy of this which he will sell please write, giving price and condition. Address Box 516, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 3-15-1

WANTED—Engineers in their spare time and salesmen who carry side lines and visit engineers to sell the Selden and Zena packings. Both packings have shown their worth by use in largest plants. Randolph Brandt, 70 Cortlandt St., New York. 3-15-6

For Sale

ELECTRICIANS—Send $1.50 for 16 blue prints of Motor Windings, 12 A.C. Single, two and three-phase and 6 D.C. or set of 24 A.C., 6 D.C. and 6 Rotary Converter Drawings for $2.25. Connecting and Winding made easy. Superior Electric Co., Lock Box 1372, Pittsburgh, Pa. 3-15-2

FOR SALE—BOILERS. Two 150 hp. H. R. T. Boilers, butt strapped construction, 120 lb. pressure, $1000 each. 400 hp. Atlas Watertube Boiler with Murphy Stoker and Superheater, built for 210 lb. pressure, 4 years' service, $5000. Power Machinery Exchange, Inc., Jersey City, N. J. tf.

FOR SALE—Indicator, outside spring trill, suitable for steam or gas engine, with full set of springs, scales and reducing wheel outfit in hardwood case. Good as new. Also planimeter in leather case with full directions. Price reasonable. H. W. Jones, 955 Monadnock Bldg., 4-1-2

FOR SALE—One 30-kw. 125-v. d.c. compound wound generator, direct connected to 8 in. x 9 in. 325 r.p.m. slide valve Armington-Sims steam engine. Also one 80-hp. return tubular boiler. All in good condition. Address Mr. I. E. Safier, % L. Bamberger & Co., Newark, N. J.

FOR SALE—Engine, McIntosh & Seymour, 100 hp., center crank, high speed; Atlas engine, center crank, 30 hp.; dynamo, 20 kw. d.c; dynamo, 60 kw. d.c. Right price for quick sale. National Motor Car & Vehicle Corporation, Indianapolis, Ind. 4-1-1

FOR SALE—Boilers (with stokers):

	H.P.	Make	Pressure	Each
Four	400	B. & W.	150	$6000
Three	375	Heine	150	5500
One	306	Heine	175	6000
One	225	Heine	175	4500

Power Machinery Exchange, Inc., Jersey City, N. J.

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St. N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

FACTORY MANAGERS, ENGINEERS AND OWNERS—Coal is high and scarce. Let us tell you how to conserve it and utilize your exhaust steam for heating and drying purposes. Address Monash Engineering Co., 1413 W. Jackson Boulevard, Chicago, Ill. tf.

Sparks From The Advertising Pages

Where Buyers and Sellers Meet

Cold, Lukewarm or Hot—Which?

"Because thou art lukewarm, and neither cold nor hot," said St. John, "I will spue thee out of my mouth."

The fire of patriotism is being measured in the soul of every citizen today.

If he be cold in this mighty struggle his place is the internment camp or against a stone wall. If he be hot for liberty he is fighting for freedom, abroad or at home, as his country most needs him.

Lukewarm "patriots" are an abomination in the sight of every true American.

It was men who were hot with patriotism who abandoned their plows in the furrows to seize guns and powder horns to win liberty at Bunker Hill.

Only men hot with patriotism can decide this final issue which determines whether the world shall be wholly free or wholly under the heel of a heartless autocracy.

And at the lukewarm men will be thundered from the throats of the returning millions:

"What did you do at home while we fought your fight in the trenches?"

Every power plant man, from the humblest helper to the biggest corporation president, is charged with a mighty task in this cosmic struggle.

Because in his hands is placed the power that is back of the power that will win the war.

By the nature of his profession he is charged with a responsibility that is **greater** than mere observance of food or any other regulations which every citizen must observe.

His to conserve the resources and increase the power—factors that in the final show-down bring victory or defeat.

Power plant men who are fired with the hot flame of patriotism are seeking **every** way, every hint, by which they can help win the war. They study the advertising pages of POWER PLANT ENGINEERING to find the latest machinery, the best appliances to increase the efficiency of their plants.

They see in a weak packing, a loose valve or a leaky union, coal lost to the nation that might drive a battleship.

They make it their business to know through measuring and recording instruments that they are getting full efficiency from the resources with which the nation entrusts them.

They select engines, boilers, blowers, insulation, boiler settings with the one purpose—to furnish the power to fabricate the wings of victory.

Are you lukewarm or hot with patriotism?